

2006 Buick Lucerne CXS

2006 BRAKES Hydraulic Brakes - Lucerne

2006 BRAKES

Hydraulic Brakes - Lucerne

SPECIFICATIONS

FASTENER TIGHTENING SPECIFICATIONS

Fastener Tightening Specifications

Application	Specification	
	Metric	English
Accelerator Pedal-to-Brake Pedal Mounting Bolts (ETC)	10 N.m	89 lb in
Brake Hose Bracket-to-Strut Bolt - Front	17 N.m	13 lb ft
Brake Hose Bracket Bolt - Front	13 N.m	115 lb in
Brake Hose Bracket Bolt - Rear	13 N.m	115 lb in
Brake Hose to Caliper Bolt	40 N.m	30 lb ft
Brake Master Cylinder Mounting Nut	30 N.m	22 lb ft
Brake Pedal Assembly to Booster Stud Mounting Nuts	30 N.m	22 lb ft
Brake Pipe Fitting at Master Cylinder (Tube Nut)	29 N.m	21 lb ft
Brake Pipe Fitting (Tube Nut)	15 N.m	11 lb ft

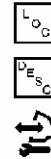
BRAKE SYSTEM SPECIFICATIONS

Brake System Specifications

Application	Specification	
	Metric	English
Brake Pedal Travel	60.00 mm	2.36 in
Maximum specification with 445 N (100 lb) of force applied to the brake pedal, the ignition OFF and the brake booster power reserve depleted.		

SCHEMATIC AND ROUTING DIAGRAMS

BRAKE WARNING SYSTEM SCHEMATICS



HYDRAULIC BRAKE COMPONENT VIEWS

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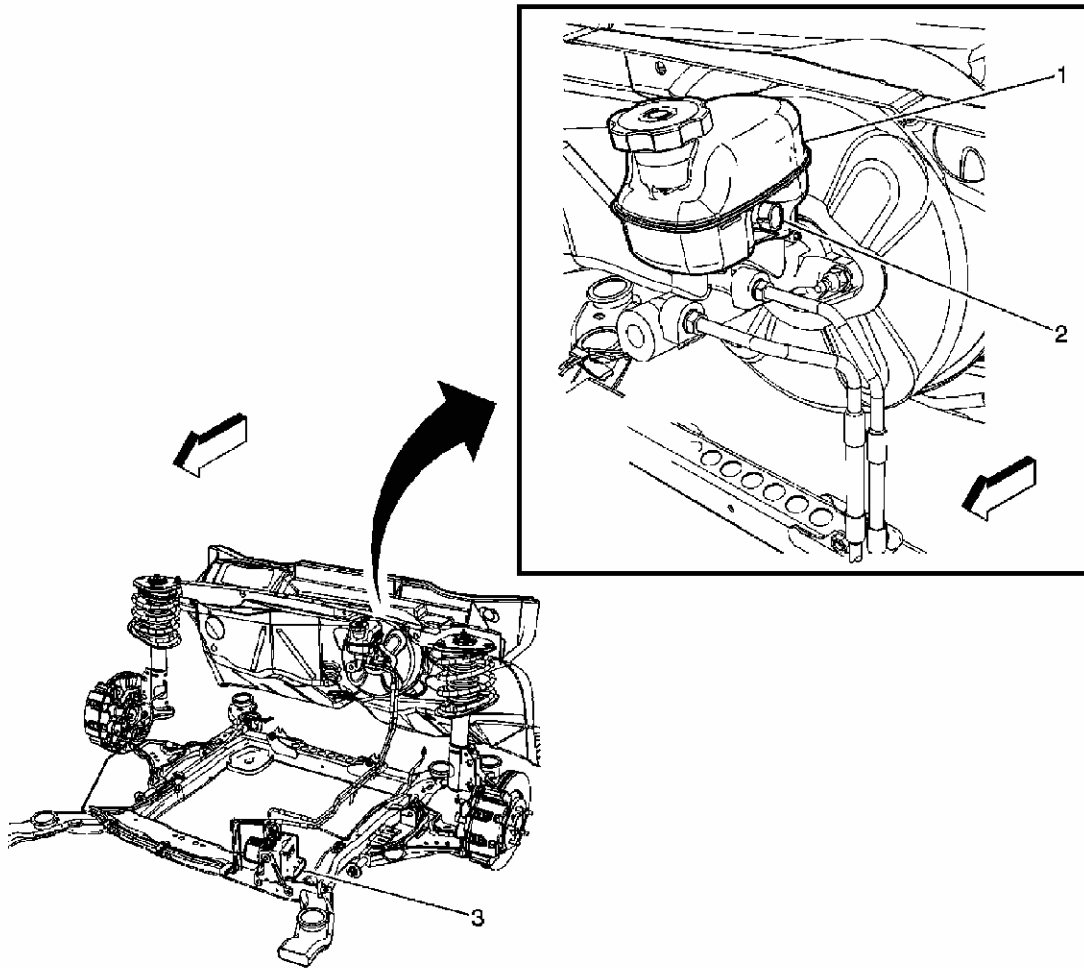


Fig. 2: View Of Left Rear Of Engine Compartment
Courtesy of GENERAL MOTORS CORP.

Callouts For Fig. 2

Callout	Component Name
1	Master Cylinder Reservoir
2	Brake Fluid Level Switch
3	Electronic Brake Control Module (EBCM)

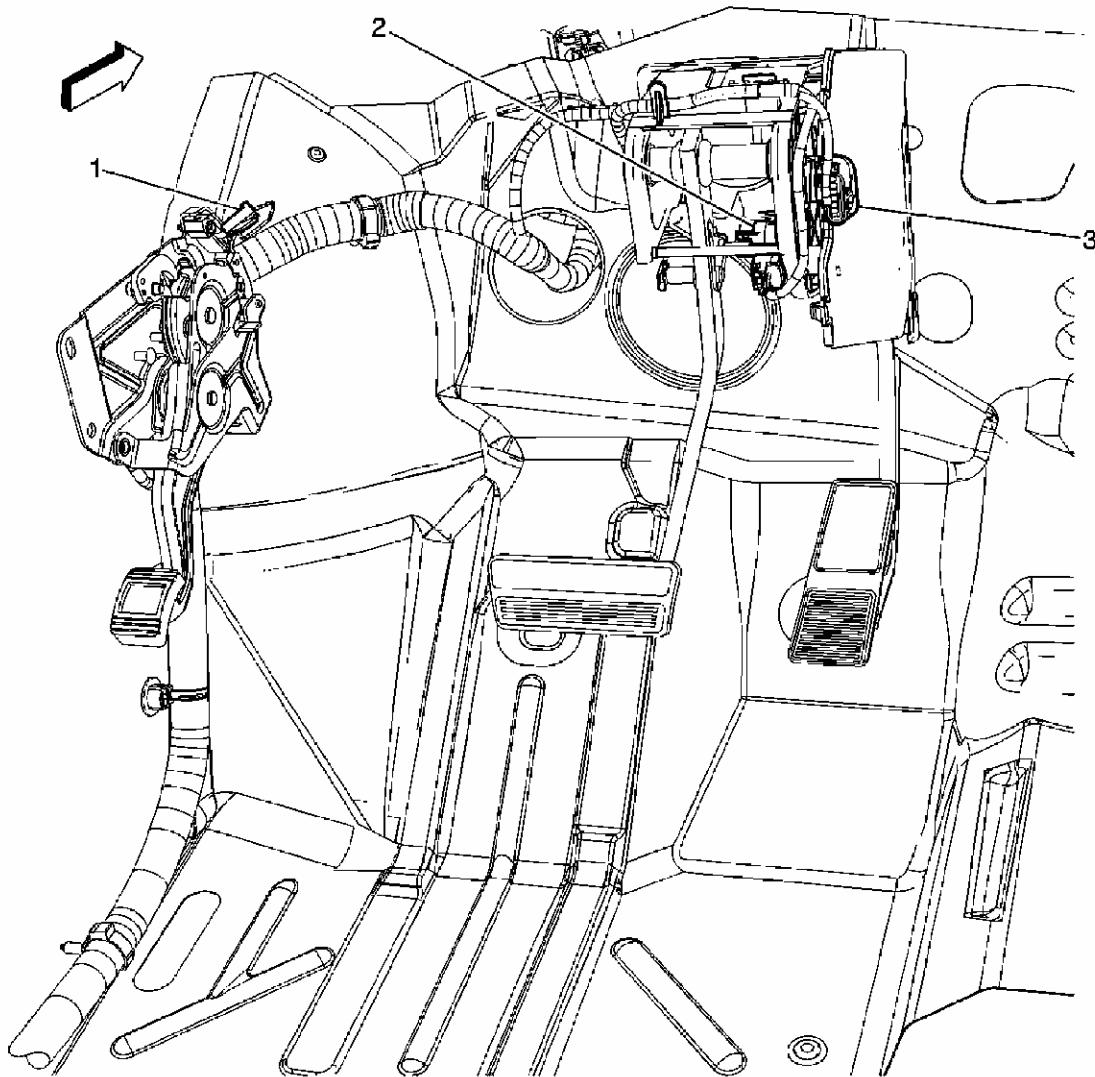


Fig. 3: View Of Lower Left Side Of I/P
Courtesy of GENERAL MOTORS CORP.

Callouts For Fig. 3

Callout	Component Name
1	Park Brake Switch
2	Brake Pedal Position Sensor
3	Accelerator Pedal Position (APP) Sensor

HYDRAULIC BRAKE CONNECTOR END VIEWS

Brake Fluid Level Switch

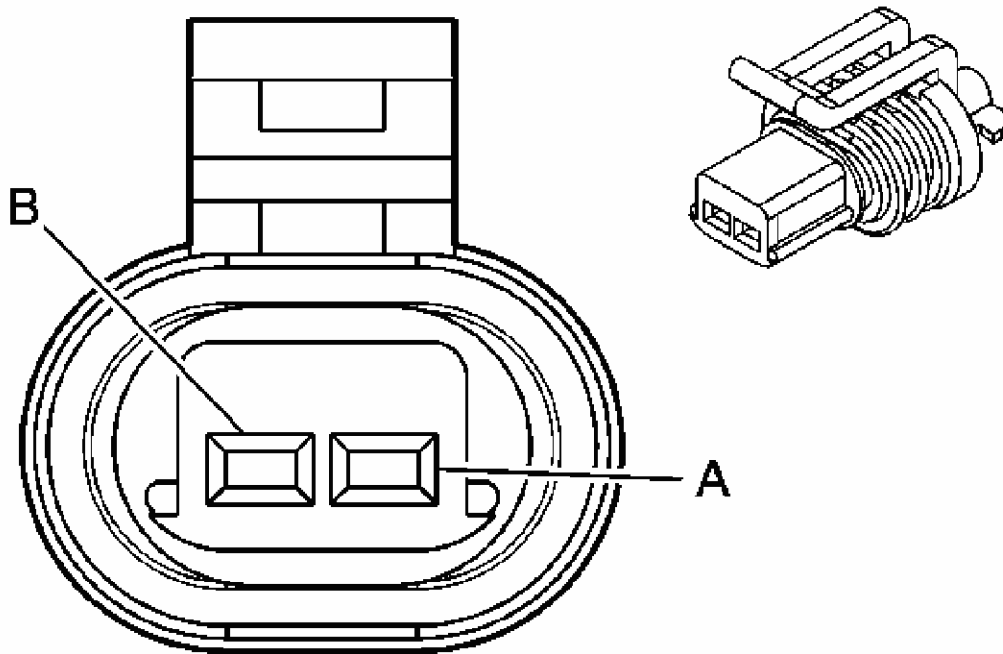


Fig. 4: Brake Fluid Level Switch Connector End View
Courtesy of GENERAL MOTORS CORP.

Hydraulic Brake Connector End Views

Connector Part Information

- OEM: 15336024
- Service: 88987993
- Description: 2-Way F GT 150 Sealed (BK)

Terminal Part Information

- Terminal/Tray: See Terminal Repair Kit
- Core/Insulation Crimp: See Terminal Repair Kit
- Release Tool/Test Probe: See Terminal Repair Kit

Brake Fluid Level Switch

Pin	Wire Color	Circuit No.	Function
A	TN/WH	33	Brake Fluid Level Sensor Signal
B	BK	350	Ground

Park Brake Switch

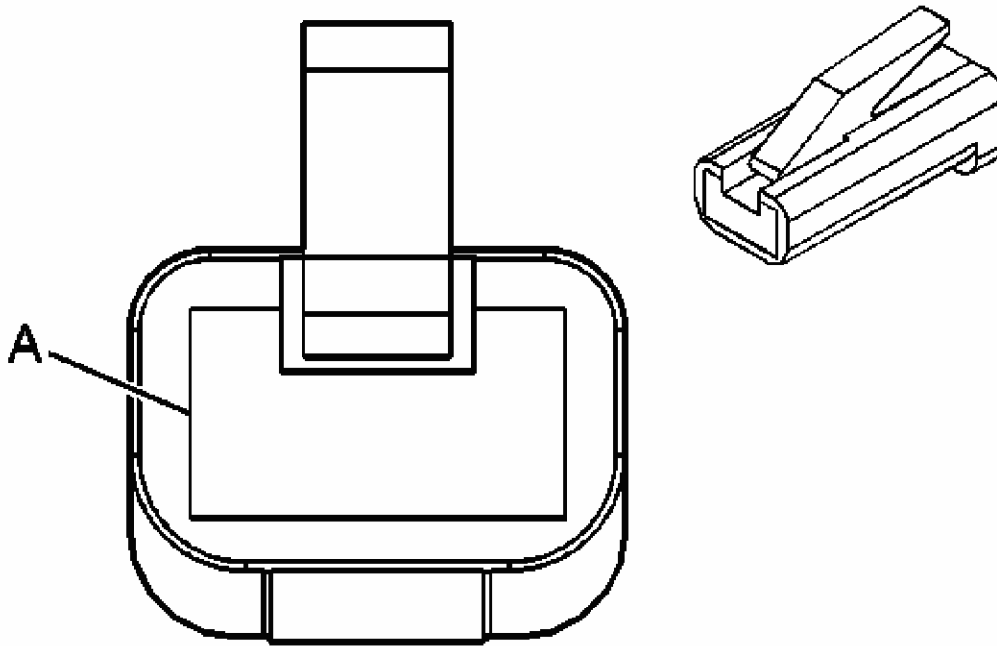


Fig. 5: Park Brake Switch Connector End View
Courtesy of GENERAL MOTORS CORP.

Hydraulic Brake Connector End Views

Connector Part Information

- OEM: 12004267
- Service: 12102561
- Description: 1-Way F 56 Series Lock Type (BK)

Terminal Part Information

- Terminal/Tray: 12124515/1
- Core/Insulation Crimp: C/D
- Release Tool/Test Probe: 12094430/J-35616-42 (RD)

Park Brake Switch

Pin	Wire Color	Circuit No.	Function
A	L-BU/WH	1134	Park Brake Switch Signal

DIAGNOSTIC INFORMATION AND PROCEDURES

DIAGNOSTIC STARTING POINT - HYDRAULIC BRAKES

Begin the hydraulic brake system diagnosis with the **Diagnostic System Check - Vehicle** . The Diagnostic System Check will provide the following information:

- The identification of the control modules which command the system.
- The ability of the control modules to communicate through the serial data circuit.
- The identification of any stored diagnostic trouble codes (DTCs) and their status.

The use of the Diagnostic System Check will identify the correct procedure for diagnosing the system and where the procedure is located.

SCAN TOOL DATA LIST

Instrument Panel Cluster (IPC)

Scan Tool Parameter	Data List	Units Displayed	Typical Data Value
Ignition ON, engine OFF, brake fluid level normal and park brake released.			
Brake Fluid Switch	Data	OK/Low	OK
Park Brake Switch	Inputs	On/Off	Off

SCAN TOOL DATA DEFINITIONS

Brake Fluid Switch

The scan tool displays OK or Low. The status of the brake fluid level sensor signal.

Park Brake Switch

The scan displays Off or On. The status of the park brake switch signal.

DTC C0267

DTC Descriptor

DTC C0267

Low Brake Fluid Indicated

Diagnostic Fault Information

IMPORTANT: Always perform the **Diagnostic System Check - Vehicle** prior to

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using this diagnostic procedure.

DTC C0267

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Brake Warning Indicator Control	C0267	-	-	-
Ground	-	-	-	-

Circuit/System Description

The brake fluid level switch monitors the level of brake fluid in the master cylinder. When the instrument panel cluster (IPC) sees the brake warning indicator control circuit grounded, it turns ON the red Brake indicator and sends a serial data message to the electronic brake control module (EBCM) that tells the EBCM that the brake fluid level is low.

Conditions for Running the DTC

The ignition is ON.

Conditions for Setting the DTC

Low brake fluid is detected.

Action Taken When the DTC Sets

- The EBCM disables the Antilock Brake System (ABS)/Traction Control System (TCS)/Vehicle Stability Enhancement System (VSES)/dynamic rear proportion (DRP).
- The ABS indicator turns ON.
- The Traction Control indicator turns ON.
- The red Brake warning indicator turns ON.
- The driver information center (DIC) displays the Service Stability System message.

Conditions for Clearing the DTC

- The condition for the DTC is no longer present and the DTC is cleared with a scan tool.
- The EBCM automatically clears the history DTC when a current DTC is not detected in 100 consecutive drive cycles.

Reference Information

Schematic Reference

Brake Warning System Schematics

Connector End View Reference**Antilock Brake System Connector End Views****Electrical Information Reference**

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

Scan Tool Reference**Scan Tool Data List****Circuit/System Verification**

Inspect the master cylinder reservoir for the proper brake fluid level.

- If brake fluid level is low, refer to **Hydraulic Brake System Diagnosis**.

Circuit/System Testing

Note: This test should only be performed if brake fluid is not low.

1. With the park brake released and the ignition OFF, disconnect the brake fluid level switch connector. Ignition ON, verify Brake indicator lamp on IPC is illuminated.
 - If the Brake indicator lamp is not illuminated, replace the brake fluid level switch.
2. With the ignition ON, use a scan tool to observe the Brake Fluid Switch parameter in IPC. Verify parameter is OK.
 - If the Brake Fluid Switch parameter is Low, repair short to ground in brake warning indicator control circuit.
3. Replace the IPC.

Repair Procedures

IMPORTANT: Always perform the Diagnostic Repair Verification after completing the diagnostic procedure.

- **Brake Fluid Level Indicator Switch Replacement**
- **Control Module References** for EBCM replacement, setup and programming

SYMPTOMS - HYDRAULIC BRAKES

IMPORTANT: The following steps must be completed before using the symptom tables.

1. Perform **Diagnostic System Check - Vehicle** before using the brake indicator symptom tables in order to verify that all of the following are true:
 - There are no DTCs set.
 - The control module(s) can communicate via the serial data link.
2. Perform the **Brake System Vehicle Road Test** before using the hydraulic brake symptom tables in order to duplicate the customer's concern.
3. Review the system operation in order to familiarize yourself with the system functions. Refer to the following:
 - **Brake Warning System Description and Operation**
 - **Hydraulic Brake System Description and Operation**
 - **Brake Assist System Description and Operation**
 - **Disc Brake System Description and Operation**

Visual/Physical Inspection

- Inspect for aftermarket devices which could affect the operation of the brake warning system. Refer to **Checking Aftermarket Accessories** .
- Inspect the easily accessible or visible system components for obvious damage or conditions which could cause the symptom.

Intermittent

Faulty electrical connections or wiring may be the cause of intermittent conditions. Refer to **Testing for Intermittent Conditions and Poor Connections** .

Symptom List

Refer to a symptom diagnostic procedure from the following list in order to diagnose the symptom:

- **Brake Warning Indicator Always On**
- **Brake Warning Indicator Inoperative**
- **Brake Pulsation**
- **Brake System Noise**
- **Braking Action Uneven - Pulls to One Side**
- **Braking Action Uneven - Front to Rear**
- **Brake Pedal Excessive Travel**

- **Brake Pedal Excessive Effort**
- **Brakes Drag**
- **Brake System Slow Release**
- **Brake Fluid Loss**

BRAKE WARNING INDICATOR ALWAYS ON**Diagnostic Fault Information**

IMPORTANT: Always perform the Diagnostic System Check - Vehicle prior to using this diagnostic procedure.

Circuit/System Description

The body control module (BCM) sees the park brake switch signal grounded, it sends a serial data message to the instrument panel cluster (IPC) requesting illumination of the red brake indicator.

Reference Information**Schematic Reference****Brake Warning System Schematics****Connector End View Reference****Computer/Integrating Systems Connector End Views****Electrical Information Reference**

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

Scan Tool Reference**Scan Tool Data List****Circuit/System Testing**

1. With the scan tool, select instrument panel special functions Lamp Test. Command the instrument panel lamps OFF. Verify brake lamp turns OFF.
 - If the brake lamp does not turn OFF, replace the IPC.

2. Disconnect the park brake switch. With a scan tool, observe the Park Brake Switch parameter. Verify parameter is reading ON.
 - If the parameter is OFF, replace the park brake switch.
3. Test the park brake switch signal circuit for a short to ground. Verify no short is found.
 - If short is found, repair the circuit.
4. Replace the BCM.

Repair Procedures

IMPORTANT: Always perform the Diagnostic Repair Verification after completing the diagnostic procedure.

- Parking Brake Indicator Switch Replacement
- Control Module References for IPC replacement, setup and programming

BRAKE WARNING INDICATOR INOPERATIVE

Diagnostic Fault Information

IMPORTANT: Always perform the Diagnostic System Check - Vehicle prior to using this diagnostic procedure.

Circuit/System Description

The instrument panel cluster (IPC) sees the brake fluid level switch input grounded and illuminates the red brake indicator. The body control module (BCM) sees the park brake switch input grounded, it sends a serial data message to the IPC requesting illumination of the red brake indicator.

Reference Information

Schematic Reference

Brake Warning System Schematics

Connector End View Reference

Computer/Integrating Systems Connector End Views

Electrical Information Reference

- Circuit Testing
- Connector Repairs
- Testing for Intermittent Conditions and Poor Connections

- **Wiring Repairs**

Scan Tool Reference**Scan Tool Data List****Circuit/System Testing**

1. With the scan tool, select instrument panel special functions Lamp Test. Command the instrument panel lamps ON. Verify brake lamp turns ON.
 - If the brake lamp does not turn ON, replace the IPC.
2. Release the park brake. Disconnect the brake fluid level switch. Connect a 3-amp jumper wire between the signal circuit of the brake fluid level switch and the ground circuit of the brake fluid level switch. Ignition ON, verify the brake lamp is ON.
 - If the brake lamp does not turn ON, test the signal circuit and ground circuit for a high resistance/open or replace the brake fluid level switch.
3. Disconnect the park brake switch. Connect a 3-amp jumper wire between signal circuit of the park brake switch and ground. Ignition ON, verify the brake lamp is ON.
 - If the brake lamp does not turn ON, test the signal circuit high resistance/open or replace the BCM.
4. Replace the park brake switch.

Repair Procedures

IMPORTANT: Always perform the Diagnostic Repair Verification after completing the diagnostic procedure.

- **Brake Fluid Level Indicator Switch Replacement**
- **Parking Brake Indicator Switch Replacement**
- **Control Module References** for BCM and IPC replacement, setup and programming

BRAKE PULSATION**Test Description**

The numbers below refer to the step numbers on the diagnostic table:

2: Suspension components that are not operating properly may cause a disturbance to the vehicle during application of the brake system.

3: Antilock brake system operation could produce feedback through the brake pedal during application of the brake system.

Brake Pulsation

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Step	Action	Yes	No
1	Were you sent here from the Hydraulic Brake Symptom Table?	Go to Step 2	Go to <u>Diagnostic Starting Point - Hydraulic Brakes</u>
2	Inspect the suspension system for proper operation. Refer to <u>Diagnostic Starting Point - Suspension General Diagnosis</u> . Did you find and correct a condition?	Go to Step 6	Go to Step 3
3	Inspect the antilock brake system, if equipped, for proper operation. Refer to <u>Diagnostic Starting Point - Antilock Brake System</u> . Did you find and correct a condition?	Go to Step 6	Go to Step 4
4	Inspect the disc brake system for proper operation. Refer to <u>Disc Brake System Diagnosis</u> . Did you find and correct a condition?	Go to Step 6	Go to Step 5
5	Inspect the hydraulic brake system for proper operation. Refer to <u>Hydraulic Brake System Diagnosis</u> . Did you find and correct a condition?	Go to Step 6	Go to <u>Diagnostic Starting Point - Hydraulic Brakes</u>
6	Road test the vehicle in order to confirm proper operation. Refer to <u>Brake System Vehicle Road Test</u> . Is the condition still present?	Go to Step 2	System OK

BRAKE SYSTEM NOISE

Brake System Noise

Step	Action	Yes	No
1	Were you sent here from the Hydraulic Brake Symptom table?	Go to Step 2	Go to <u>Diagnostic Starting Point - Hydraulic Brakes</u>
2	Inspect the disc brake system for proper operation. Refer to <u>Disc Brake System Diagnosis</u> . Did you find and correct a condition?	Go to Step 9	Go to Step 3

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Step	Action	Yes	No
3	Inspect the brake system for proper operation. Refer to <u>Brake Assist System Diagnosis</u> . Did you find and correct a condition?	Go to Step 9	Go to <u>Diagnostic Starting Point</u>
4	Inspect the hydraulic brake system for proper operation. Refer to <u>Hydraulic Brakes</u> . Did you find and correct a condition?	Go to Step 2	<u>Hydraulic Brakes</u>
2	Inspect the disc brake system for proper operation. Refer to <u>Disc Brake System Diagnosis</u> . Did you find and correct a condition?	Go to Step 9	Go to Step 5
5	Inspect the drum brake system for proper operation. Refer to <u>Drum Brake System Diagnosis</u> . Did you find and correct a condition?	Go to Step 9	Go to Step 3
6	Ensure the park brake shoes are not adjusted too tightly, possibly causing a noise under certain conditions. Are the park brake shoes adjusted too tightly?	Go to Step 7	Go to Step 8
7	1. Clean and inspect the park brake shoes for excessive wear and/or damage. 2. Inspect the drum portion of the rotors for excessive wear, blueing discoloration, heat spots and excessive radial runout. 3. If any of these conditions are present, replace the affected components. 4. Adjust the park brake system.		
8	Did you find and correct a condition? Inspect the park brake system for proper operation. Refer to <u>Park Brake System Diagnosis</u> . Did you find and correct a condition?	Go to Step 9	Go to Step 8 Go to <u>Diagnostic Starting Point - Hydraulic Brakes</u>
9	Road test the vehicle in order to confirm proper operation. Refer to <u>Brake System Vehicle Road Test</u> . Is the condition still present?	Go to Step 2	System OK

BRAKING ACTION UNEVEN - PULLS TO ONE SIDE

Test Description

The numbers below refer to the step numbers on the diagnostic table:

2: Suspension components that are not operating properly may cause a disturbance to the vehicle during application of the brake system.

3: Steering components that are not operating properly may cause a disturbance to the vehicle during application of the brake system.

Braking Action Uneven - Pulls to One Side

Step	Action	Yes	No
1	Were you sent here from the Hydraulic Brake Symptom table?		Go to <u>Diagnostic Starting Point - Hydraulic Brakes</u>
2	Inspect the suspension system for proper operation. Refer to <u>Diagnostic Starting Point - Suspension General Diagnosis</u> .	Go to Step 2	
3	Did you find and correct a condition? Inspect the steering system for proper operation. Refer to <u>Diagnostic Starting Point - Power Steering System (w/o Electro-Hydraulic Steering)</u> .	Go to Step 6	Go to Step 3
4	Did you find and correct a condition? Inspect the hydraulic brake system for proper operation. Refer to <u>Hydraulic Brake System Diagnosis</u> .	Go to Step 6	Go to Step 4
5	Did you find and correct a condition? Inspect the disc brake system for proper operation. Refer to <u>Disc Brake System Diagnosis</u> .	Go to Step 6	Go to Step 5
6	Did you find and correct a condition? Road test the vehicle in order to confirm proper operation. Refer to <u>Brake System Vehicle Road Test</u> .	Go to Step 6	Go to <u>Diagnostic Starting Point - Hydraulic Brakes</u>
	Is the condition still present?	Go to Step 2	System OK

BRAKING ACTION UNEVEN - FRONT TO REAR

Test Description

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The number below refers to the step number on the diagnostic table.

2: Suspension components that are not operating properly may cause a disturbance to the vehicle during application of the brake system.

Braking Action Uneven - Front to Rear

Step	Action	Yes	No
1	Were you sent here from the Hydraulic Brake Symptom table?		Go to <u>Diagnostic Starting Point - Hydraulic Brakes</u>
2	Inspect the suspension system for proper operation. Refer to <u>Diagnostic Starting Point - Suspension General Diagnosis</u> . Did you find and correct a condition?	Go to Step 2	
3	Inspect the hydraulic brake system for proper operation. Refer to <u>Hydraulic Brake System Diagnosis</u> . Did you find and correct a condition?	Go to Step 6	Go to Step 3
4	Inspect the disc brake system for proper operation. Refer to <u>Disc Brake System Diagnosis</u> . Did you find and correct a condition?	Go to Step 6	Go to Step 4
5	Inspect the brake assist system for proper operation. Refer to <u>Brake Assist System Diagnosis</u> . Did you find and correct a condition?	Go to Step 6	Go to Step 5
6	Road test the vehicle in order to confirm proper operation. Refer to <u>Brake System Vehicle Road Test</u> . Is the condition still present?	Go to Step 6	Go to <u>Diagnostic Starting Point - Hydraulic Brakes</u>
		Go to Step 2	System OK

BRAKE PEDAL EXCESSIVE TRAVEL**Brake Pedal Excessive Travel**

Step	Action	Yes	No
1	Were you sent here from the Hydraulic Brake Symptom table?		Go to <u>Diagnostic Starting Point - Hydraulic</u>

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Step	Action	Go to Step 2	Brakes
2	<p>Inspect for proper brake pedal travel. Refer to <u>Brake Pedal Travel Measurement and Inspection</u>.</p> <p>Is the brake pedal travel distance within the acceptable limits?</p> <ol style="list-style-type: none"> 1. Inspect for worn, missing, misaligned, bent or damaged brake pedal system components. <ul style="list-style-type: none"> • For the brake pedal pushrod component inspection, refer to <u>Brake Pedal Pushrod Inspection</u> . • Inspect the brake pedal bushings for excessive wear and/or damage and inspect the brake pedal for a misaligned, bent, and/or damaged condition. 2. Replace the brake pedal system components that are worn, missing, misaligned, bent or damaged. Refer to the following procedures as necessary. <ul style="list-style-type: none"> • <u>Brake Pedal Assembly Replacement</u> • <u>Power Vacuum Brake Booster Replacement (4.6L V-8)</u><u>Power Vacuum Brake Booster Replacement (3.8L V-6)</u> -for pedal pushrod replacement 	Go to Step 5	Go to Step 3
3	<p>Did you find and replace any worn, missing, misaligned, bent or damaged brake pedal system components?</p> <p>Inspect for proper brake pedal travel. Refer to <u>Brake Pedal Travel Measurement and Inspection</u>.</p> <p>Is the brake pedal travel distance within the acceptable limits?</p> <p>Inspect the hydraulic brake system for</p>	Go to Step 4	Go to Step 5
4	<p>Inspect for proper brake pedal travel. Refer to <u>Brake Pedal Travel Measurement and Inspection</u>.</p> <p>Is the brake pedal travel distance within the acceptable limits?</p> <p>Inspect the hydraulic brake system for</p>	Go to Step 8	Go to Step 5

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5	<p>Inspect for proper operation. Refer to Hydraulic Brake System Pedal Travel.</p> <p>Did you find and correct a condition?</p> <p>Inspect the brake pedal travel distance within the</p>	Go to Step 8 Go to Step 5	Go to Step 6 Go to Step 3
6	<p>operation. Refer to Disc Brake System Diagnosis.</p> <p>Inspect for worn, missing, misaligned, bent, or damaged brake pedal system components.</p> <p>Did you find and correct a condition?</p>	Go to Step 8	Go to Step 7 Go to Diagnostic Starting Point - Hydraulic Brakes
7	<p>Inspect the brake assist system for proper operation. Refer to Brake Assist System Diagnosis.</p> <p>Did you find and correct a condition?</p>	Go to Step 8	
8	<p>Inspect the brake pedal pushrod inspection.</p> <p>Inspect the brake pedal bushings for excessive wear and/or damage.</p> <p>Road test the vehicle to confirm proper operation. Refer to Brake System Vehicle Road Test.</p> <p>and inspect the brake pedal for a misaligned, bent, and/or damaged condition.</p> <p>Is the condition still present?</p>	Go to Step 2	System OK

BRAKE PEDAL EXCESSIVE EFFORT

Brake Pedal Excessive Effort

Step	Action	Yes	No
1	Were you sent here from the Hydraulic Brake Symptom table?		Go to Diagnostic Starting Point - Hydraulic Brakes
2	Inspect the brake assist system for proper operation. Refer to Brake Assist System Diagnosis .	Go to Step 2	
	Did you find and correct a condition?	Go to Step 5	Go to Step 3
3	Inspect the hydraulic brake system for proper operation. Refer to Hydraulic Brake System Diagnosis .		
	Did you find and correct a condition?	Go to Step 5	Go to Step 4
4	Inspect the disc brake system for proper operation. Refer to Disc Brake System Diagnosis .		Go to Diagnostic Starting Point - Hydraulic Brakes
	Did you find and correct a condition?	Go to Step 5	
5	Road test the vehicle to confirm proper operation. Refer to Brake System		

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Step	Vehicle Road Test Action	Yes	No
	Were you sent here from the Hydraulic Brake Symptom table?	Go to Step 2	System OK

BRAKES DRAG

Brakes Drag

Step	Action	Yes	No
1	Were you sent here from the Hydraulic Brake Symptom table?		Go to Diagnostic Starting Point - Hydraulic Brakes
2	Is the vehicle equipped with an adjustable stop lamp switch and/or an adjustable cruise control release switch?	Go to Step 2	Go to Step 4
3	<ol style="list-style-type: none"> 1. Inspect the stop lamp switch for proper adjustment to ensure that the brake pedal is fully releasing. 2. Inspect the cruise control release switch, if equipped, for proper adjustment to ensure that the brake pedal is fully releasing. 	Go to Step 3	
4	Did you find and correct a condition?	Go to Step 14	Go to Step 4
5	Is the vehicle equipped with a drum-in-rotor type of park brake system?	Go to Step 5	Go to Step 7
6	<p>Ensure the park brake shoes are not adjusted too tightly, possibly causing drag under certain conditions.</p> <p>Are the park brake shoes adjusted too tightly?</p> <ol style="list-style-type: none"> 1. Clean and inspect the park brake shoes for excessive wear and/or damage. 2. Inspect the drum portion of the rotors for excessive wear, blueing discoloration, heat spots and excessive radial runout. 3. If any of these conditions are present, replace the affected components. 4. Adjust the park brake system. 	Go to Step 6	Go to Step 7

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Step	Did you find and correct a condition?	Yes	No
1	Were you sent here from the Hydraulic Brake Symptom table? Inspect the park brake system for proper operation. Refer to <u>Park Brake System Diagnosis</u> . Did you find and correct a condition?	Go to Step 14	Go to Step 7
2	Inspect the disc brake system for proper operation. Is the vehicle equipped with an adjustable stop lamp switch and/or an adjustable cruise control release switch? Did you find and correct a condition?	Go to Step 14 Go to Step 2	Go to Step 8 <u>Diagnostic Starting Point Hydraulic Brakes</u>
3	1. Inspect the stop lamp switch for proper adjustment to ensure that the brake pedal is fully releasing. 2. Inspect the brake corners to determine if the brake drag condition is still present. Do the brake corners still exhibit the brake drag condition? Did you find and correct a condition?	Go to Step 3 Go to Step 14	Go to Step 4 Go to Step 9
10	Replace the brake pedal assembly. Is the vehicle equipped with a drum-in-rotor type of park brake system? Did you complete the replacement?	Go to Step 11 Go to Step 14	Go to Step 10 Go to Step 4
5	1. Separate the brake shoes and liner from the brake booster. Do not disconnect any brake lines. Are the park brake shoes adjusted too tightly?		-
11	2. Inspect the brake corners to determine if the brake drag condition is still present.	Go to Step 6	Go to Step 7
12	Do the brake corners still exhibit the brake drag condition? Replace the brake booster assembly. Did you complete the replacement?	Go to Step 13 Go to Step 14	Go to Step 12 -
13	Inspect the hydraulic brake system for proper operation. Refer to <u>Hydraulic Brake System Diagnosis</u> . Did you find and correct a condition?	Go to Step 14	Go to <u>Diagnostic Starting Point - Hydraulic Brakes</u>
14	1. Install or connect components that were removed or disconnected during diagnosis. 2. Road test the vehicle in order to confirm proper operation. Refer to		

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Brake System Vehicle Road Test

1. Inspect the park brake shoes for excessive wear and/or damage.
Is the condition still present?

Go to **Step 2**

System OK

BRAKE SYSTEM SLOW RELEASE

Brake System Slow Release

Step	Action	Yes	No
1	Were you sent here from the Hydraulic Brake Symptom table?	Go to Step 2	Go to <u>Diagnostic Starting Point - Hydraulic Brakes</u>
2	Inspect the hydraulic brake system for proper operation. Refer to <u>Hydraulic Brake System Diagnosis</u> . Did you find and correct a condition?	Go to Step 5	Go to Step 3
3	Inspect the brake assist system for proper operation. Refer to <u>Brake Assist System Diagnosis</u> . Did you find and correct a condition?	Go to Step 5	Go to Step 4
4	Inspect the disc brake system for proper operation. Refer to <u>Disc Brake System Diagnosis</u> . Did you find and correct a condition?	Go to Step 5	Go to <u>Diagnostic Starting Point - Hydraulic Brakes</u>
5	Road test the vehicle to confirm proper operation. Refer to <u>Brake System Vehicle Road Test</u> . Is the condition still present?	Go to Step 2	System OK

BRAKE FLUID LOSS

Brake Fluid Loss

Step	Action	Yes	No
1	Were you sent here from the Hydraulic Brake Symptom table?	Go to Step 2	Go to <u>Diagnostic Starting Point - Hydraulic Brakes</u>
	Inspect the hydraulic brake system for proper operation. Refer to <u>Hydraulic</u>		

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2	<p><u>Brake System Diagnosis.</u> Did you find and correct a condition? Inspect the disc brake system for proper operation. Refer to <u>Disc Brake System Diagnosis.</u></p>	Go to Step 6	Go to Step 3
3	<p>Did you find and correct a condition?</p> <ol style="list-style-type: none"> 1. Separate the master cylinder from the vacuum brake booster. Do not disconnect any brake pipes. Refer to <u>Master Cylinder Replacement.</u> 	Go to Step 6	Go to Step 4
4	<ol style="list-style-type: none"> 2. Inspect the rear of the master cylinder for a brake fluid leak. 3. Inspect for brake fluid in the vacuum brake booster. 	Go to Step 5	<p>Go to <u>Diagnostic Starting Point - Hydraulic Brakes</u></p>
5	<p>Did you find a brake fluid leak? Replace the brake master cylinder and the vacuum brake booster. Refer to <u>Master Cylinder Replacement</u> and <u>Power Vacuum Brake Booster Replacement (4.6L V-8)</u> or <u>Power Vacuum Brake Booster Replacement (3.8L V-6).</u></p>	Go to Step 6	-
6	<p>Did you complete the replacement?</p> <ol style="list-style-type: none"> 1. Install or connect components that were removed or disconnected during diagnosis. 2. Road test the vehicle to confirm proper operation. Refer to <u>Brake System Vehicle Road Test.</u> 	Go to Step 2	System OK

DISC BRAKE SYSTEM DIAGNOSIS

Test Description

The numbers below refer to the step numbers on the diagnostic table:

9: Lubricant leaks from non-brake system components may come in contact with and contaminate brake system components.

10: Lubricant leaks from non-brake system components may come in contact with and contaminate brake system components.

12: Disc brake rotor shields/backing plates that come in contact with disc brake rotors may cause brake system noise.

15: Disc brake rotor thickness variation that exceeds the maximum acceptable level can cause brake pulsation.

19: Disc brake rotor thickness variation that exceeds the maximum acceptable level can cause brake pulsation.

22: Disc brake rotor assembled lateral runout (LRO) that exceeds the maximum acceptable level can lead to thickness variation.

Disc Brake System Diagnosis

Step	Action	Yes	No
DEFINITION: This diagnostic table is designed to diagnose ONLY the components of the DISC brake system in order to determine if the DISC brake system is operating properly. You will be directed by the appropriate Symptom table to go to other brake system diagnostic tables as appropriate.			
1	Were you sent here from a Brake Symptom table?	Go to Step 2	Go to <u>Diagnostic Starting Point - Hydraulic Brakes</u>
2	<p>Visually inspect the disc brake pads for the following conditions: Refer to <u>Brake Pad Inspection</u> .</p> <ul style="list-style-type: none"> • Lining thickness below specifications • Uneven and/or abnormal wear - edge-to-edge and/or side-to-side • Looseness or damage - including pad hardware • Evidence of contamination from an external substance <p>Did you find any conditions to indicate a concern with any of the front and/or rear disc brake pads?</p>		
		Go to Step 3	Go to Step 12

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Step	Are any of the front and/or rear disc brake pads contaminated?	Yes	No
3	Are any of the front and/or rear disc brake pads contaminated?	Go to Step 8	Go to Step 4
4	Is the front disc brake system operating properly?	Go to Step 7	Go to Step 5
5	Are pads and/or calipers loose or damaged?	Go to Step 7	Go to Step 6
1	1. Remove and inspect the worn disc brake pads for glazing, looseness, heat spots or damage.	Go to Step 2	Diagnostic Starting Point Hydraulic Brakes
6	<p>Visually inspect the disc brake pads for the following conditions:</p> <p>2. Replace the worn disc brake pads as a complete axle set. Refer to Front Disc Brake Pads Replacement and/or Rear Disc Brake Pads Replacement.</p> <p>Did you complete the inspection and replacement?</p> <p>NOTE:</p> <p>Support the brake caliper with heavy mechanic wire or equivalent, whenever it is separated from its mount and the hydraulic flexible brake hose is still connected. Failure to support the caliper in this manner will cause the flexible brake hose to bear the weight of the caliper, which may cause damage to the brake hose and in turn may cause a brake fluid leak.</p> <p>IMPORTANT:</p> <p>Do NOT disconnect the hydraulic brake flex hoses from the calipers.</p> <p>1. Remove the front and/or rear disc brake calipers, as appropriate, from the mounting brackets and support the calipers. Refer to Front Brake Caliper Replacement and/or Rear Brake Caliper Replacement.</p> <p>2. Inspect the disc brake caliper mounting bracket and the mounting/sliding hardware for the</p>	Go to Step 12	-

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2	<ul style="list-style-type: none"> • following conditions: Lining thickness below specifications Refer to Front Disc Brake Mounting and Hardware Inspection and/or Rear Disc Brake Mounting and Hardware Inspection. • Evidence of contamination from an external substance <ul style="list-style-type: none"> • Binding or seized hardware • Worn, damaged or missing hardware components <p>Did you find any conditions to indicate a concern with any of the front and/or rear disc brake pads?</p>	Go to Step 3	Go to Step 11
3	<p>Are any of the front and/or rear disc brake pads contaminated?</p> <p>5. Replace components as required. Refer to the following procedures:</p>	Go to Step 8	Go to Step 4
4	<p>Are any of the front and/or rear disc brake pads worn unevenly?</p> <p>• Front Brake Caliper Bracket Replacement</p>	Go to Step 7	Go to Step 5
5	<p>Are any of the front and/or rear disc brake pads and/or pad hardware loose or damaged?</p> <p>• Rear Brake Caliper Bracket Replacement</p>	Go to Step 7	Go to Step 6
6	<ul style="list-style-type: none"> • Front Disc Brake Hardware Replacement • Rear Disc Brake Hardware Replacement <p>1. Remove and inspect the worn disc brake pads for glazing, looseness, heat spots or damage.</p> <p>2. Replace the worn disc brake pads as a complete axle set. Refer to Front Disc Brake Pads Replacement and/or Rear Disc Brake Pads Replacement.</p> <p>4. Replace the unevenly worn, loose or damaged disc brake pads as a complete axle set. Refer to Front Disc Brake Pads Replacement and/or Rear Disc Brake Pads Replacement.</p> <p>Did you complete the inspection and replacement?</p>	Go to Step 12	-
	<p>Did you complete the inspection and replacement?</p> <p>1. Inspect the disc brake calipers, brake hoses and brake pipes for evidence of an external brake fluid leak.</p> <p>2. Replace any components found to be leaking brake fluid. Refer to the following procedures as required:</p>	Go to Step 12	

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flexible brake hose to bear the weight of the caliper, which may cause damage to the brake hose and in turn may cause a brake fluid leak.

- **Rear Brake Caliper**

- **Overhaul or Rear Brake Caliper Replacement**

Do NOT disconnect the hydraulic brake flex hoses from the calipers.

- **Front Brake Hose**

- **Replacement**

1. Remove the front and/or rear disc brake caliper and appropriate, from the mounting brackets and support the calipers. Refer to **Front Brake Caliper Replacement** and/or **Rear**

Did you find and correct the source of the leak causing contamination of the pads? mounting bracket and the

Go to **Step 11**Go to **Step 9**

7

1. Inspect the wheel drive shaft outer seals for damage and evidence of a grease leak.

Refer to **Front Disc Brake**

2. Replace any wheel drive shaft seal that is found to be leaking grease which may be the source of the contamination to the pads. Refer to **Front Disc Brake Mounting and Hardware Inspection** and **Wheel Drive Shaft Outer Joint and Boot Replacement**.

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- Binding or seized hardware

Did you find and correct the source of the leak causing contamination of the pads? • Worn, damaged or missing hardware components

Go to **Step 11**Go to **Step 10**

1. Inspect the automatic transmission bracket for damage and evidence of an external fluid leak which may be the source of the contamination to the pads.
2. Inspect the brake caliper bracket hoses for damage and evidence of an external fluid leak which may be the source of the contamination to the pads.

- **Front Brake Caliper Bracket Replacement**

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2. Inspect the brake caliper bracket hoses for damage and evidence of an external fluid leak which may be the source of the contamination to the pads.
3. Replace any components found to

- **Front Disc Brake Hardware**

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	<p>be leaking. Replacement which may be the source of the contamination to the pads.</p> <ul style="list-style-type: none"> • Rear Disc Brake Hardware Replacement <p>4. Replace the unevenly worn, loose or damaged disc brake pads as a complete axle set. Refer to Front Disc Brake Pads Replacement</p> <p>1. Clean the remaining disc brake and/or Rear Disc Brake Pads Replacement system components to remove any traces of the contaminant.</p> <p>Did you complete the inspection and replacement?</p> <p>NOTE:</p>	<p>Go to Step 11</p> <p>Go to Step 12</p>	
8 11	<p>Support the brake caliper with heavy inspection of disc brake calipers, brake hoses and brake pipes for evidence of an external brake fluid leak.</p> <p>2. Support the caliper in this manner to be cause the flexible brake hose to bear the weight of the caliper, which may cause damage to the brake hose and in turn Front Brake Caliper leak.</p> <p>Overhaul or Front Brake Caliper Replacement</p> <p>IMPORTANT:</p> <p>Do NOT disconnect the hydraulic brake flex hoses from the calipers.</p> <ul style="list-style-type: none"> • Rear Brake Caliper Overhaul or Rear Brake Caliper Replacement <p>2. Remove the front and/or rear disc brake caliper, as appropriate, from the mounting and support the calipers. Refer to Front Brake Caliper Replacement and/or Rear Brake Caliper Replacement and/or Brake Pipe Replacement.</p> <p>Did you inspect the disc brake caliper mounting/sliding hardware for the leak causing contamination of the pads?</p>	<p>Go to Step 11</p>	Go to Step 9
	<p>following conditions:</p> <p>1. Inspect the wheel drive shaft outer seals for damage and evidence of a grease leak. Refer to Front Disc Brake Mounting and Hardware Inspection.</p> <p>2. Replace any wheel drive shaft seal that is found to be leaking grease. Refer to Rear Disc Brake Mounting and Hardware Inspection.</p> <ul style="list-style-type: none"> • Binding or seized hardware 		

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9	<p>which may be the source of the contamination to the pads. Refer to Wheel Drive Shaft Outer Joint and Boot Replacement.</p> <p>4. Replace the caliper mounting/sliding hardware components as required. Refer to Front Disc Brake Hardware Replacement and/or Rear Disc Brake Hardware Replacement.</p> <p>Did you find and correct the source of the leak causing contamination of the pads?</p>	Go to Step 11	Go to Step 10
10	<p>1. Inspect the automatic transmission cooling system lines, if equipped, for damage and evidence of an external fluid leak which may be the source of the contamination to the pads. Refer to Front Disc Brake Pads Replacement and/or Rear Disc Brake Pads Replacement.</p> <p>2. Inspect the power steering system hoses for damage and evidence of an external fluid leak which may be the source of the contamination to the pads.</p> <p>Did you complete the cleaning, inspection and replacement?</p>	Go to Step 12	-
12	<p>3. Replace any components found to be leaking fluid which may be the source of the contamination to the pads.</p> <p>Are any of the brake rotor shields/backing plates contacting the brake rotors?</p> <p>Did you find and correct the source of the leak causing contamination of the pads?</p> <p>Repair or replace the disc brake rotor shields/backing plates as required. Refer to Rear Wheel Bearing and Hub Replacement.</p> <p>Did you complete the repair or replacement?</p>	Go to Step 13 Go to Step 11	Go to Step 14
13	<p>shields/backing plates as required. Refer to Rear Wheel Bearing and Hub Replacement.</p> <p>Did you complete the repair or replacement?</p>	Go to Step 14	-
14	<p>1. Check the thickness of each of the disc brake rotors.</p> <p>IMPORTANT: Make the following determination AND ANSWER the question INDIVIDUALLY for EACH rotor.</p> <p>2. Make a determination for each brake rotor if the rotor can be REFINISHED and REMAIN ABOVE the minimum requirements.</p>		

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	<p>Refer to Brake Rotor Thickness Measurement. Does the disc brake rotor thickness fall within the limits for REFINISHING?</p> <p>1. IMPORTANT: Do not disconnect the hydraulic brake flex hoses from the calipers until the mounting cups are under tension.</p> <p>per With heavy mechanic wire or Perform the following inspection AND answer the question INDIVIDUALLY for EACH rotor. The hydraulic flexible brake hose is still connected. Failure to support the caliper in this manner will cause the flexible brake hose to bear the weight of the rotor and cause a variation in thickness. Does the brake rotor exhibit thickness variations that cause the brake hose to pull laterally? Cause a fluid leak.</p> <p>1. Inspect each of the disc brake rotors for the following surface and wear conditions:</p> <p>Refer to Brake Rotor Surface and Wear Inspection. Remove the front and/or rear disc brake calipers, as appropriate, from the mounting brackets and support the calipers. Refer to Front Brake Caliper and/or Rear Brake Caliper for inspection. Deep or excessive scoring beyond maximum acceptable level.</p> <p>2. Inspect the mounting/sliding hardware for the following conditions:</p> <p>Refer to Front Disc Brake and Rear Disc Brake for inspection. Make a determination INDIVIDUALLY for EACH rotor.</p> <p>and/or Rear Disc Brake Mounting and Wear Inspection.</p> <p>2. Make a determination for each brake rotor if the rotor requires refinishing based upon the results of the inspection.</p> <p>If the brake rotor exhibits any of</p>	Go to Step 15	Go to Step 18
15	<p>Inspect each of the disc brake rotors for thickness variations that cause the flexible brake hose to bear the weight of the rotor and cause a variation in thickness. Does the brake rotor exhibit thickness variations that cause the brake hose to pull laterally? Cause a fluid leak.</p> <p>1. Inspect each of the disc brake rotors for the following surface and wear conditions:</p>	Go to Step 17	Go to Step 16
11			-
16	<p>Refer to Brake Rotor Surface and Wear Inspection. Remove the front and/or rear disc brake calipers, as appropriate, from the mounting brackets and support the calipers. Refer to Front Brake Caliper and/or Rear Brake Caliper for inspection. Deep or excessive scoring beyond maximum acceptable level.</p> <p>2. Inspect the mounting/sliding hardware for the following conditions:</p> <p>Refer to Front Disc Brake and Rear Disc Brake for inspection. Make a determination INDIVIDUALLY for EACH rotor.</p> <p>and/or Rear Disc Brake Mounting and Wear Inspection.</p> <p>2. Make a determination for each brake rotor if the rotor requires refinishing based upon the results of the inspection.</p> <p>If the brake rotor exhibits any of</p>	Go to Step 12	

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12	<p>equipped, and the vehicle is listed frontally with the brake rotors refinishing.</p> <p>Are any of the brake rotor shields/backing plates/backing the brake rotors?</p>	Go to Step 13	Go to Step 14
13	<p>REFINISHING?</p> <p>Repair or replace the disc brake rotor shield/backing plate as required. Refer to Repair Wheel Bearing and Hub Replacement.</p>	Go to Step 17	Go to Step 22
17	<p>2. Inspect the brake rotor thickness. Did you complete the repair or replacement?</p> <p>Refer to Brake Rotor Thickness Measurement.</p>	Go to Step 14	-
18	<p>1. Check the thickness of each of the disc brake rotors. Were you able to REFINISH the brake rotor within the minimum requirements?</p> <p>Is the brake rotor below the MINIMUM THICKNESS requirements?</p> <p>IMPORTANT: Make the following determination AND ANSWER the question INDIVIDUALLY for EACH rotor.</p>	Go to Step 22	Go to Step 21
14	<p>Perform the following inspection AND ANSWER the question INDIVIDUALLY for EACH rotor.</p> <p>Make a determination for each brake rotor if the rotor can be REFINISHED and REMAIN ABOVE the minimum requirements.</p>	Go to Step 21	Go to Step 19
19	<p>Inspect each of the disc brake rotors for thickness variation that exceeds the maximum acceptable level. Refer to Brake Rotor Thickness Variation Measurement. Does the disc brake rotor meet the minimum requirements for REFINISHING? Does the brake rotor exhibit thickness variation that exceeds the maximum acceptable level?</p>	Go to Step 15	Go to Step 18
15	<p>IMPORTANT:</p> <p>1. Inspect each of the disc brake rotors for the following surface and wear conditions:</p> <p>Refer to Brake Rotor Surface and Wear Inspection for thickness needs the maximum acceptable level. Refer to Brake Rotor Thickness Variation Measurement. Does the brake rotor exhibit thickness variation that exceeds the maximum acceptable level?</p> <ul style="list-style-type: none"> Excessive bluing discoloration 	Go to Step 17	Go to Step 16
	<ul style="list-style-type: none"> Deep or excessive scoring beyond maximum acceptable level 		

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20	<p>IMPORTANT: Make the following determination AND ANSWER the question INDIVIDUALLY for EACH rotor.</p> <p>2. Make a determination for each brake rotor if the rotor requires replacement based upon the results of the inspection.</p> <ul style="list-style-type: none"> • /or pitting <p>If the brake rotor exhibits any of the conditions listed previously, it requires replacement beyond maximum</p>	Go to Step 21	Go to Step 22
16	<p>IMPORTANT: Does the rotor require REPLACEMENT? Make the following determination AND ANSWER the question INDIVIDUALLY for EACH rotor.</p> <p>Whenever a brake rotor is replaced, the assembled lateral runout (LRO) of the rotor must be measured for each rotor.</p>	Go to Step 21	Go to Step 22
21	<p>Make a determination for each brake rotor if the rotor requires refinishing.</p> <p>Replace the brake rotor. Refer to Front Brake Rotor Replacement or Rear Brake Rotor Replacement.</p> <p>Did you complete the replacement?</p>	Go to Step 24	-
	<p>IMPORTANT: If the brake rotor exhibits any of the conditions listed previously, it requires refinishing. Perform the following inspection AND ANSWER the question INDIVIDUALLY for EACH rotor.</p>	Go to Step 17	Go to Step 21
22	<p>1. Refinish the brake rotor. Refer to Brake Rotor Refinishing.</p>	Go to Step 23	Go to Step 24
17	<p>2. Inspect the brake rotor thickness. Refer to Brake Rotor Thickness Measurement.</p> <p>Does the brake rotor exhibit assembled LRO that exceeds the maximum acceptable level? Were you able to REFINISH the brake rotor within the minimum requirements? Correct the LRO for each brake rotor that was determined to have MINIMUM THICKNESS requirements?</p>	Go to Step 22	Go to Step 2
18	<p>Is the brake rotor below the MINIMUM THICKNESS requirements?</p>	Go to Step 21	Go to Step 15
23	<p>exceeding the maximum acceptable level. Refer to Brake Rotor Assembled Lateral Runout Correction.</p> <p>Did you complete the operation?</p>	Go to Step 24	-

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IMPORTANT: Disconnect components that were removed the following inspection AND answer the question INDIVIDUALLY for EACH rotor.
Did you complete the operation?

Disc Brake System OK
Return to Symptom Table

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HYDRAULIC BRAKE SYSTEM DIAGNOSIS

Hydraulic Brake System Diagnosis

Step	Action	Yes	No
DEFINITION: This diagnostic table is designed to diagnose ONLY the components of the HYDRAULIC brake system in order to determine if the HYDRAULIC brake system is operating properly. You will be directed by the appropriate Symptom table to go to other brake system diagnostic tables as appropriate.			
1	Were you sent here from a Brake Symptom table?	Go to Step 2	Go to <u>Diagnostic Starting Point - Hydraulic Brakes</u>
2	Inspect and adjust the brake fluid level in the brake master cylinder. Refer to <u>Master Cylinder Reservoir Filling</u> . Was the brake fluid level low?	Go to Step 3	Go to Step 4
3	<ol style="list-style-type: none"> Inspect the brake fluid for the following conditions, indicating brake fluid contamination: <ul style="list-style-type: none"> Fluid separation, indicating two types of fluid are present <ul style="list-style-type: none"> Swirled appearance-Oil-based substance Layered appearance-Silicone-based substance Fluid discoloration <ul style="list-style-type: none"> Cloudy appearance-Moisture Dark appearance/suspended particles in fluid-Dirt, rust, corrosion, brake dust Inspect the master cylinder reservoir cap diaphragm and the reservoir-to- 		

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Step	Action	Yes	No
4	<p>DEFINITION: This diagnostic table is designed to diagnose ONLY the components of the master cylinder reservoir cap diaphragm and the reservoir-to-master cylinder grommets for swelling, indicating fluid contamination.</p> <p>Do any of the above conditions exist?</p> <p>1. Inspect the brake fluid for the following conditions, indicating brake fluid contamination:</p> <ul style="list-style-type: none"> • Fluid separation, indicating two types of fluid are present <ul style="list-style-type: none"> ■ Swirled appearance-Oil-based substance ■ Layered appearance-Silicone-based substance • Fluid discoloration <ul style="list-style-type: none"> ■ Cloudy appearance-Moisture ■ Dark appearance/suspended particles in fluid-Dirt, rust, corrosion, brake dust <p>2. Inspect the master cylinder reservoir cap diaphragm and the reservoir-to-master cylinder grommets for swelling, indicating fluid contamination.</p>	Go to Step 5	Go to Step 6
	<p>Do any of the above conditions exist?</p> <p>1. Flush the hydraulic brake system. Refer to <u>Hydraulic Brake System Flushing</u>.</p> <p>2. If the brake fluid WAS contaminated with an oil-based or a silicone-based fluid, indicated by fluid separation and/or a swollen master cylinder reservoir cap diaphragm and/or swollen reservoir-to-master cylinder grommets, perform the following steps. Refer to the procedures indicated.</p>	Go to Step 5	Go to Step 12

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HYDRAULIC brake system in order to determine if the HYDRAULIC brake system is operating properly. You will be directed by the appropriate Symptom table to go to other brake system diagnostic tables as appropriate.

1	<p>1. Remove ALL of the following components listed. Each component contains internal rubber seals/linings which have been contaminated.</p> <p>2. Clean out the hydraulic brake pipes using denatured alcohol or equivalent.</p>	Go to Step 2	Go to <u>Diagnostic Starting Point - Hydraulic Brakes</u>
2	<p>3. Dry the brake pipes using non-lubricated, filtered air.</p> <p>4. Repair or replace ALL of the following components listed.</p> <p>Was the brake fluid level low?</p>	Go to Step 3	Go to Step 4
5	<p>1. Inspect the brake fluid for the following conditions, indicating brake fluid contamination:</p> <ul style="list-style-type: none"> • Fluid separation, indicating two types of fluid are present <ul style="list-style-type: none"> • Swirled appearance-Oil-based substance • Master Cylinder Reservoir Replacement • Cloudy appearance-Moisture • Dark appearance/suspended particles in fluid-Dirt, rust, corrosion, brake dust <p>2. Inspect the master cylinder reservoir cap diaphragm and the reservoir-to-master cylinder grommets for swelling, indicating fluid contamination.</p>	Go to Step 5	-
3	<p>Do any of the following conditions exist?</p> <ul style="list-style-type: none"> • Front Brake Hose Replacement • Rear Brake Hose Replacement • Front Brake Caliper Overhaul or Front Brake Caliper Replacement • Rear Brake Caliper Replacement • Brake Pressure 	Go to Step 5	Go to Step 6

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4	<p>types <u>Modulator Valve</u></p> <ul style="list-style-type: none"> ■ <u>Replacement</u> <p>3. If the brake fluid substance is NOT contaminated with an oil based fluid, but WAS contaminated with water or dirt, rust, corrosion, and/or brake dust, replace the brake master cylinder reservoir cap diaphragm which may have allowed moisture or dirt to enter the system.</p> <p>4. Refill and bleed the hydraulic brake system. Refer to <u>Hydraulic Brake System Bleeding (Manually)</u> or <u>Hydraulic Brake System Bleeding (Pressure)</u>.</p> <p>2. <u>System Bleeding (Manually)</u> or <u>Hydraulic Brake System Bleeding (Pressure)</u>.</p> <p>Did you complete the operation and any required repairs and/or replacements?</p>	Go to Step 5	Go to Step 1
6	<p>1. Inspect the following hydraulic brake system components for external fluid leaks. Repair or replace any of the components found to be leaking brake fluid. Refer to the appropriate procedures:</p> <ul style="list-style-type: none"> ● <u>Master Cylinder Replacement</u> <p>Brake master cylinder reservoir cap diaphragm</p> <ul style="list-style-type: none"> ● <u>Front Brake Hose Replacement</u> ● <u>Rear Brake Hose Replacement</u> ● <u>Brake Pipe Replacement</u> ● <u>Front Brake Caliper Overhaul</u> or <u>Front Brake Caliper Replacement</u> ● <u>Rear Brake Caliper Overhaul</u> or <u>Rear Brake Caliper Replacement</u> 		

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	<ul style="list-style-type: none"> Flush the hydraulic brake system. Brake Pressure Modulator Water Replacement Hydraulic Brake System Flushing 		
	<ol style="list-style-type: none"> 1. If you repaired or replaced any of the brake system components listed, bleed the hydraulic brake system. Refer to Hydraulic Brake System Bleeding (Manual) or Hydraulic Brake System Bleeding (Pressure). While bleeding the hydraulic brake system, observe for the following conditions: <ul style="list-style-type: none"> The presence of air in the system at a bleeder valve location other than at the repair location, except if the brake master cylinder was replaced. An unrestricted and even flow of brake fluid per axle during the bleeding procedure. 		
5	Did you find and correct a condition?	Go to Step 7	Go to Step 12
7	Was there air in the system at a bleeder valve location other than at the repair location, except if the brake master cylinder was replaced?	Go to Step 19	Go to Step 8
8	Was the flow of brake fluid unrestricted and even per axle during the bleeding procedure?	Go to Step 9	Go to Step 10
9	Inspect the hydraulic function of the brake calipers for proper operation. Refer to Hydraulic Brake Component Operation Visual Inspection . Was the hydraulic function of the brake calipers operating properly?	Go to Step 21	Go to Step 14
10	Was the flow of brake fluid restricted or uneven through front axle hydraulic components during the bleeding procedure?	Go to Step 13	Go to Step 11
11	Was the flow of brake fluid restricted or uneven through rear axle hydraulic components during the bleeding procedure?	Go to Step 17	-

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12	<p>Inspect the hydraulic function of the brake caliper as follows:</p> <p>Refer to enter Hydraulic Brake Component Operation</p> <p>Visual Inspection</p> <p>Remove and bleed the hydraulic brake system. Refer to Hydraulic Brake System Bleeding (Manual) or Hydraulic Brake System Bleeding (Pressure).</p> <p>Determine if the brake caliper is restricting the flow of brake fluid and/or not operating properly:</p> <p>Did you complete the operation and any required repairs and/or replacements?</p>	Go to Step 15	Go to Step 13
13	<p>to Lifting and Jacking the Vehicle.</p> <ol style="list-style-type: none"> 1. Inspect the following hydraulic brake system components for external fluid leaks. Repair or replace any of the components found to be leaking brake fluid. 2. Open the master cylinder bleeder valve. 3. Use the appropriate procedures: 4. Using Master Cylinder Replacement, remove the master cylinder and observe for an unrestricted flow of brake fluid and for free movement of the caliper piston. 5. Close the caliper bleeder valve. <p>• Front Brake Hose Replacement</p> <p>• Rear Brake Hose Replacement</p> <p>• Brake Pipe Replacement</p> <p>• Front Brake Caliper Overhaul or Front Brake Caliper Replacement</p> <p>• Rear Brake Caliper Overhaul or Rear Brake Caliper Replacement</p> <p>• Brake Pressure Modulator or Valve Replacement</p> <p>• Rear Brake Caliper Replacement</p> <p>2. If you repaired or replaced any of the brake system components listed, bleed the hydraulic brake system. Refer to the appropriate procedure:</p> <p>Did you complete the repair and/or replacement?</p>	Go to Step 17	Go to Step 14
14	<p>Repair or replace any brake caliper that was not operating properly. Refer to the appropriate procedure:</p> <p>• Rear Brake Caliper Overhaul or Rear Brake Caliper Replacement</p> <p>• Front Brake Caliper Overhaul or Front Brake Caliper Replacement</p> <p>• Brake Pressure Modulator or Valve Replacement</p> <p>• Rear Brake Caliper Replacement</p> <p>2. If you repaired or replaced any of the brake system components listed, bleed the hydraulic brake system. Refer to the appropriate procedure:</p> <p>Did you complete the repair and/or replacement?</p>	Go to Step 21	-
	Bleed the hydraulic brake system to observe for the presence of air in the		

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15	<p>system. Hydraulic Brake System Bleeding and even (Manual) for Hydraulic Brake System Bleeding (Pressure). While Hydraulic Brake System Bleeding system, (Manual) for Hydraulic Brake System Bleeding (Pressure).</p> <p>The presence of air in the system. Was there air in the system?</p> <p>Was the flow of brake fluid unrestricted, except and even per the bleeding procedure?</p>	Go to Step 19	Go to Step 16
16	<p>replaced.</p> <p>1. Inspect the hydraulic brake system for signs of flexible brake hoses for signs of the fluid restricting procedure, such as being bent, kinked, pinched or damaged. Refer to Brake Pipe and Hose Inspection.</p> <p>Did you find and correct a condition?</p>	Go to Step 21	Go to Step 17
7	<p>2. Replace any of the hydraulic brake pipes and/or flexible brake hoses found to be bent, kinked, pinched or damaged. Refer to the following procedure as necessary:</p> <p>• Front Brake Hose Replacement</p> <p>• Rear Brake Hose Replacement</p> <p>Inspect the hydraulic function of the brake calipers for proper operation. Refer to Hydraulic Brake Component Operation Visual Inspection.</p> <p>Was the hydraulic function of the brake pipes or calipers proper?</p>	Go to Step 7	Go to Step 1
8 17	<p>Was the flow of brake fluid unrestricted and even per axle during the bleeding procedure?</p> <p>• Front Brake Hose Replacement</p> <p>• Rear Brake Hose Replacement</p> <p>Inspect the hydraulic function of the brake calipers for proper operation. Refer to Hydraulic Brake Component Operation Visual Inspection.</p> <p>Was the hydraulic function of the brake pipes or calipers proper?</p>	Go to Step 19	Go to Step 8
9	<p>Was the flow of brake fluid unrestricted and even through the hydraulic hose component during the bleeding procedure?</p> <p>Was the flow of brake fluid restricted or uneven through rear axle hydraulic components during the bleeding procedure?</p> <p>Did you find and correct a condition?</p>	Go to Step 9	Go to Step 1
10	<p>Replace the brake pressure modulator valve (BPMV) in order to correct the hydraulic brake dynamic rear calipers for proper operation. Refer to Hydraulic Brake Component Operation Visual Inspection.</p> <p>Did you complete the replacement?</p>	Go to Step 21	Go to Step 1
11	<p>1. Inspect the hydraulic brake system</p>	Go to Step 13	Go to Step 1
12	<p>1. Inspect the hydraulic brake system</p>	Go to Step 21	Go to Step 18
	<p>1. Inspect the hydraulic brake system</p>	Go to Step 17	
	<p>1. Inspect the hydraulic brake system</p>	Go to Step 21	-
	<p>1. Inspect the hydraulic brake system</p>		

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	Was the hydraulic fluid taken from the brake at caliper seal and fitting location, which may have drawn air into the system?	Go to Step 15	Go to Step 1
19	Determine if the brake caliper is restricting the flow of brake fluid and/or not operating properly. Inspect the hydraulic and brake system components for evidence of a recent repair, which may have introduced air into the system. 1. Raise and support the vehicle. Refer to Lifting and Jacking the Vehicle . 3. Repair or replace any of the components found to be installed incorrectly. 2. Remove the tire and wheel assemblies. Refer to Tire and Wheel Removal and Installation .		
13	Did you find and correct a condition? 5. Open the suspected caliper bleeder valve. 1. Inspect the brake master cylinder for internal flange leaks. Refer to Brake System Internal Leak Test for an unrestricted flow of brake fluid and for free movement of the caliper piston. 4. Install or correct components that were found to be leaking. 2. Repair or replace the brake master cylinder if it is found to be leaking. 5. Use the caliper bleed reference.	Go to Step 21	Go to Step 20
20	Was the fluid and brake fluid condition noted and corrected? 1. Was the fluid and brake fluid condition noted and corrected?	Go to Step 21	Return to Symptom Table
	Did the caliper piston move freely? Install or correct components that were found to be leaking.	Go to Step 17	Go to Step 1
21	Did the caliper piston move freely? Repair or replace any of the components found to be leaking. Did operating procedure operation? the appropriate procedure:	Brake System OK Return to Symptom Table	-

BRAKE ASSIST SYSTEM DIAGNOSIS

Brake Assist System Diagnosis

Step	Action	Yes	No
DEFINITION: This diagnostic table is designed to diagnose ONLY the components of the brake ASSIST system in order to determine if the brake ASSIST system is operating properly. You will be directed by the appropriate Symptom table to go to other brake system diagnostic tables as appropriate.			
1	Were you sent here from a Brake Symptom table?	Go to Step 3	Go to Step 2
2	Were you sent here directly from an electrical diagnostic to investigate vacuum as a possible concern?		Go to Diagnostic Starting Point - Hydraulic

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3	<p>Inspect for proper brake pedal travel. Refer to <u>Brake Pedal Travel Measurement and Inspection</u>.</p> <p>Is the brake pedal travel distance within the acceptable limits?</p>	<p>Go to Step 5</p> <p>Go to Step 5</p>	<p><u>Brakes</u></p> <p>Go to Step 4</p>
4	<ol style="list-style-type: none"> 1. Inspect for worn, missing, misaligned, bent or damaged brake pedal system components. <ul style="list-style-type: none"> • For the brake pedal pushrod component inspection, refer to <u>Brake Pedal Pushrod Inspection</u>. • Inspect the brake pedal bushings for excessive wear and/or damage and inspect the brake pedal for a misaligned, bent, and/or damaged condition. 2. Replace the brake pedal system components that are worn, missing, misaligned, bent or damaged. <p>Did you find and replace any worn, missing, misaligned, bent or damaged brake pedal system components?</p>	<p>Go to Step 5</p> <p>Go to Step 5</p>	<p>Inspect for internal and external fluid leaks and air in the hydraulic brake system</p> <p>Go to <u>Hydraulic Brake System Diagnosis</u></p>
5	<p>Check the engine vacuum source that supplies vacuum to the vacuum brake booster. Refer to <u>Brake System Vacuum Source Test</u>.</p> <p>Is the vacuum reading within the acceptable limits?</p>	<p>Go to Step 6</p>	<p>Go to Engine Controls Diagnostics Information</p>
6	<p>Does the condition occur during cold start-up conditions?</p>	<p>Go to Step 7</p>	<p>Go to Step 8</p>
7	<p>Check engine vacuum under the same cold start-up conditions. Refer to appropriate Engine Controls Diagnostics article.</p> <p>Did you find and correct a condition?</p>	<p>Go to Step 18</p>	<p>Go to Step 9</p>
8	<p>During the vacuum source test, did the vacuum booster check valve operate</p>		

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Step	properly?	Action	Go to Step 10	Go to Step 9
DEFINITION	Is this the master cylinder designed to diagnose ONLY the components of the brake ASSIST system?	Refer to Vacuum Brake Booster if the brake ASSIST system is operating properly. You must check the appropriate Symptom table to go to other brake system diagnosis.		
1	Were you complete the replacement?		Go to Step 10	
1	Is equipped with a booster mounted		Go to Step 3	Go to Step 2
10	Separate vacuum sensor, inspect the electrical diagnostic for five stages, vacuum as a possible damage? Does the vacuum sensor grommet exhibit any of the conditions listed?		Go to Step 11	Go to Diagnostic Starting Point Hydraulic 2
11	Replace the vacuum sensor grommet. Did you complete the replacement?		Go to Step 12	-
12	<ol style="list-style-type: none">1. Separate the master cylinder from the vacuum brake booster. Do not disconnect any brake pipes. Before removing the master cylinder, first deplete the vacuum by removing the check valve or applying the brake pedal several times. Refer to Master Cylinder Replacement.2. If equipped with a vacuum seal on the rear of the master cylinder, inspect the seal for damage and correct positioning on the master cylinder.3. If equipped with a vacuum seal that is part of the booster, inspect the seal for damage.4. Inspect the master cylinder mating surface of the booster for deformation and or damage. Does the vacuum seal and/or the master cylinder mating surface of the of the booster exhibit any of the conditions listed?		Go to Step 13	Go to Step 14
	<ol style="list-style-type: none">1. If equipped with a vacuum seal on the rear of the master cylinder, replace the vacuum seal as			

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	necessary.	Go to Step 5	Brakes
3	Inspect for proper brake pedal travel that Refer to Brake Pedal Travel which is Measure the and Inspection		
13	Is the brake pedal travel distance within the acceptable limits? 5. If the master cylinder mating	Go to Step 5	Go to Step 4
	1. surface of the booster was, deformed and/or damaged, replace the booster. • For the brake pedal pushrod Did you complete the replacement? component inspection, refer to Brake Pedal Pushrod Inspection .	Go to Step 14	
4	Perform the vacuum boost functional test: • Inspect the brake pedal 1. Reinstall the master cylinder to the bushings for excessive wear and/or damage and inspect the engine was started after 2. If the brake pedal for a misaligned, bent, and/or damaged condition. 2. Replace the brake pedal system components that are worn, missing, misaligned, bent or damaged.		Inspect for internal and external fluid leaks and air in the hydraulic brake system Go to Hydraulic Brake System Diagnosis
14	Will the engine OFF, depress the brake pedal several times to deplete the vacuum reserve. Did you find and replace any worn, missing, misaligned, bent or damaged brake pedal system components?	Go to Step 5	
5	IMPORTANT: Check the engine vacuum source that supplies the brake pedal should fall slightly, then hold. Refer to Brake System Vacuum Source Test . 4. Start the engine and observe pedal operation. Is the vacuum reading within the acceptable limits?	Go to Step 6	Go to Engine Controls Diagnostics Information
6	Does the condition occur during cold start-up conditions? Is there an audible vacuum leak coming from the brake pedal area?	Go to Step 7	Go to Step 8
	Check engine vacuum under the same cold start-up conditions. Refer to appropriate Engine Controls Diagnostics article.	Go to Step 17	Go to Step 15
15	Did the brake pedal fall slightly after the engine was started, then hold? Did you find and correct a condition?	Go to Step 16 Go to Step 18	Go to Step 17 Go to Step 9
	Perform the vacuum booster leak down test: 1. Release the brake pedal.		

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8	2. Accelerate the engine to approximately 3,000 RPM, then release the throttle. Wait 2-3 seconds. Did you complete the replacement?	Go to Step 10	Go to Step 9
9	3. Turn the ignition OFF. Wait 60 seconds. Did you complete the replacement?	Go to Step 10	-
10	IMPORTANT: If equipped with a booster mounted separate vacuum sensor, inspect the vacuum sensor grommet for cracks, cuts, dry-rot or damage. • Both pedal applies should be assisted. • The amount of assist could diminish slightly with the second apply. Does the vacuum sensor grommet exhibit any of the conditions listed?	Go to Step 11	Go to Step 11
11	5. Depress the brake pedal 2 times to check for vacuum booster available vacuum reserve. Observe pedal effort. Did you complete the replacement?	Go to Step 12	-
	1. Separate the master cylinder from the vacuum brake booster. Do not disconnect any brake pipes. Before removing the master cylinder, first deplete the vacuum by removing the check valve or applying the brake pedal several times. Refer to Master Cylinder Replacement (4.6L V-8) or Power Vacuum Brake Booster Replacement (3.8L V-6) . 2. If equipped with a vacuum seal on the rear of the master cylinder, inspect the seal for damage and correct positioning on the master cylinder. Did you complete the replacement?	Go to Step 18	Go to Step 17
17	Replace the vacuum brake booster. Refer to Power Vacuum Brake Booster Replacement (4.6L V-8) or Power Vacuum Brake Booster Replacement (3.8L V-6) . 2. If equipped with a vacuum seal on the rear of the master cylinder, inspect the seal for damage and correct positioning on the master cylinder. Did you complete the replacement?	Go to Step 18	-
12	Install or connect any components that were removed or disconnected during diagnosis.	Brake Assist System OK	-
18	3. If equipped with a vacuum seal that is part of the booster, inspect the seal. Did you complete the operation?	Return to Symptom Table	-

BRAKE SYSTEM VEHICLE ROAD TEST

Preliminary Inspections

1. Visually inspect easily accessible brake system components for obvious damage and/or leaks which may indicate that the vehicle should not be driven until further inspections have been completed.
2. Inspect the brake master cylinder reservoir fluid level and adjust only if necessary for brake system road testing. Refer to **Master Cylinder Reservoir Filling**.
3. Inspect the tire inflation pressures and adjust as necessary.

4. Inspect the tire tread patterns to ensure that they are the same or very similar, especially per axle.
5. Ensure that the vehicle is not loaded unevenly prior to brake system road testing.

Road Testing Procedure

CAUTION: Road test a vehicle under safe conditions and while obeying all traffic laws. Do not attempt any maneuvers that could jeopardize vehicle control. Failure to adhere to these precautions could lead to serious personal injury and vehicle damage.

1. Start the engine and allow it to idle.
2. Check to see if the brake system warning lamp remains illuminated.
3. If the brake system warning lamp remains illuminated, DO NOT proceed to test drive the vehicle until it is diagnosed and repaired. Refer to **Symptoms - Hydraulic Brakes**.
4. Select a smooth, dry, clean and level road or large lot that is as free of traffic and obstacles as possible for brake system low speed road testing.
5. With the transmission in PARK, lightly apply the brake pedal. Observe both the pedal feel and the pedal travel.
6. If the brake pedal apply felt spongy or the pedal travel was excessive, DO NOT drive the vehicle until it is repaired.
7. If the brake pedal apply did not feel spongy and the pedal travel was not excessive, proceed to step 8.
8. Release and apply the brakes.
9. While continuing to apply the brakes, shift the transmission into DRIVE, release the brakes and allow the engine to idle the vehicle away from the stopped position. Observe for a slow release of the brake system.
10. With the aid of an assistant to observe the vehicle's performance from outside of the vehicle, drive the vehicle at a low speed and lightly apply the brakes while driving past the assistant. Have the assistant observe for brake system noise from the side of the vehicle closest to them, while you observe both the pedal effort and the pedal travel.
11. If the brake pedal apply effort was excessive or the pedal travel was excessive, DO NOT continue to test drive the vehicle until it is repaired.
12. If the brake pedal apply effort was not excessive and the pedal travel was not excessive, proceed to step 13.
13. Drive the vehicle in the opposite direction, at the same low speed and lightly apply the brakes while driving past the assistant. Have the assistant observe for brake system noise from the side of the vehicle closest to him.
14. Drive the vehicle at a low speed and shift the transmission into NEUTRAL without

applying the brakes. Observe for a rapid deceleration in vehicle speed, indicating possible brake drag.

15. Select a smooth, dry, clean and level road that is as free of heavy traffic as possible for brake system moderate speed road testing.
16. Drive the vehicle at a moderate speed. Observe for a pull and/or incorrect tracking of the vehicle without the brakes applied.
17. While continuing to drive the vehicle at a moderate speed, perform several light applies of the brakes. Observe the pedal effort and the pedal travel, observe for brake system noise, pulsation and/or brake drag.
18. If the brake pedal apply effort was excessive or the pedal travel was excessive, DO NOT continue to test drive the vehicle until it is repaired.
19. If the brake pedal apply effort was not excessive and the pedal travel was not excessive, proceed to step 20.
20. While continuing to drive the vehicle at a moderate speed, perform several moderate applies of the brakes. Observe the pedal effort and the pedal travel, observe for brake system pulsation and/or uneven braking action - either side to side or front to rear.

A small amount of vehicle front end dip is expected during a moderate apply of the brakes.

21. If the brake pedal apply effort was excessive or the pedal travel was excessive, DO NOT continue to test drive the vehicle until it is repaired.

BRAKE PEDAL TRAVEL MEASUREMENT AND INSPECTION

Tools Required

J 28662 Brake Pedal Effort Gage. See **Special Tools**.

Procedure

1. With the ignition OFF and the brakes cool, apply the brakes 3-5 times or until the brake pedal effort increases significantly, in order to deplete the brake booster power reserve.
2. Install the **J 28662** to the brake pedal. See **Special Tools**.

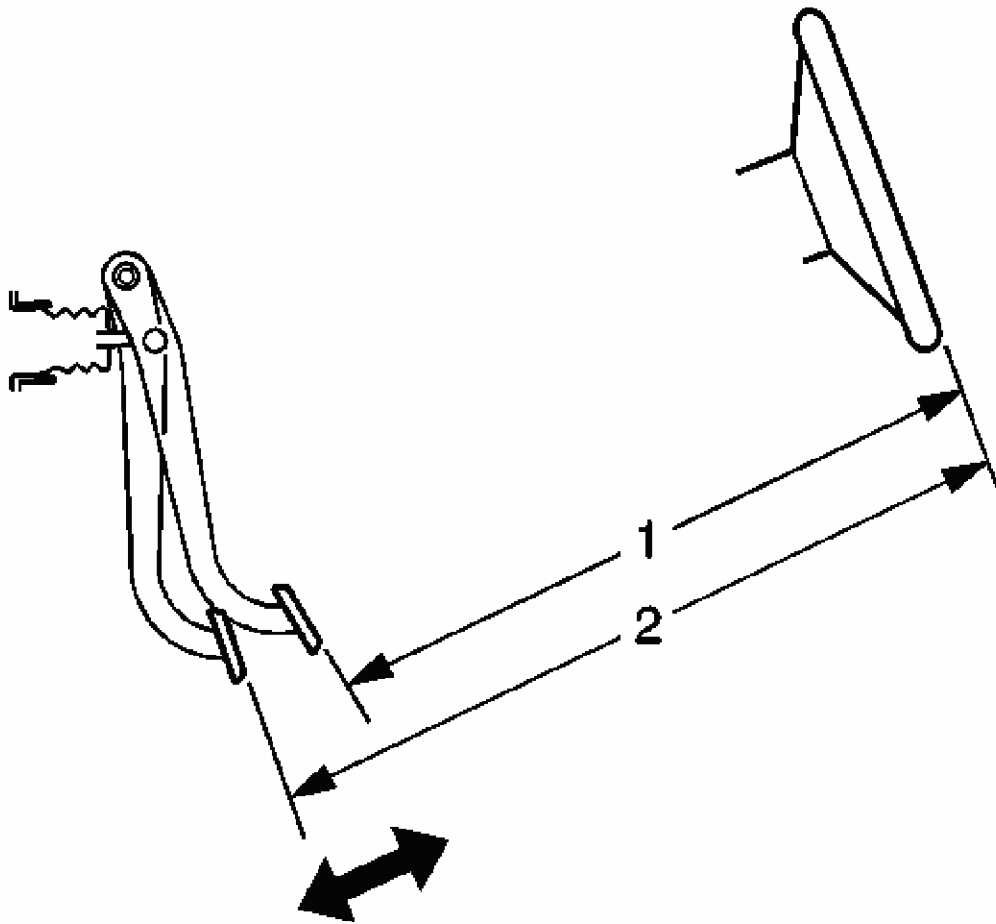


Fig. 6: Measuring Brake Pedal Travel
Courtesy of GENERAL MOTORS CORP.

3. Measure and record the distance (1) from the brake pedal to the rim of the steering wheel; note the points of measurement.
4. Apply and maintain the brakes with 445 N (100 lb) of force to the brake pedal, as indicated on the **J 28662** . See **Special Tools**.
5. While maintaining 445 N (100 lb) of force to the brake pedal, measure and record the distance (2) from the same point on the brake pedal to the same point on the rim of the steering wheel.
6. Release the brakes and repeat steps 4 and 5 to obtain a second measurement. After obtaining a second measurement, proceed to step 7.
7. Average the first and second measurements recorded during the two applies of the brakes.

8. Subtract the initial measurement, unapplied (1), from the averaged, applied measurement (2) to obtain the brake pedal travel distance.

Specification: Maximum brake pedal travel-measured with the ignition OFF, brake booster power assist depleted and the brakes cool: 57 mm (2.24 in)

BRAKE SYSTEM VACUUM SOURCE TEST

IMPORTANT:

- **Engine temperature, accessory load and elevation level will affect engine vacuum.**
- **Vacuum readings will decrease by approximately 2.7 kPa (0.8 in HG) for every 305 m (1000 ft) of elevation above sea level.**

1. Disconnect the engine vacuum hose from the vacuum brake booster check valve.
2. Install a vacuum gage to the engine vacuum hose.
3. Start the engine and allow the engine to idle until normal operating temperatures are reached.
4. With the vehicle in PARK, the engine idling and the air conditioning (A/C) system OFF, check to see if the engine vacuum reading is within the specified normal engine vacuum range.

Specification: 47-68 kPa (14-20 in Hg)

5. Turn the ignition OFF.
6. If the engine vacuum reading is within the specified normal range, proceed to step 10.
7. If the engine vacuum reading is NOT within the specified normal range, inspect the engine vacuum hose for the following conditions:
 - Loose connection to the engine
 - Collapse, deformation or contamination
 - Cracks, cuts, dry-rot
8. If any of these conditions were found with the engine vacuum hose, replace the hose, then repeat steps 2-4.
9. If none of these conditions were found with the engine vacuum hose, then there is an engine vacuum source problem, check the engine vacuum system.
10. Remove the vacuum brake booster check valve from the booster.
11. Install the check valve to the engine vacuum hose.
12. Install the vacuum gage to the check valve.
13. Start the engine and allow the engine to idle in PARK with the A/C system OFF, until

normal operating temperatures are reached.

14. Turn the ignition OFF.
15. Check to see if the engine vacuum reading is maintained within the specified normal engine vacuum range.

Specification: 47-68 kPa (14-20 in Hg)

16. If the engine vacuum reading is maintained within the specified normal range, proceed to step 18.
17. If the engine vacuum reading is NOT maintained within the specified normal range, replace the brake booster check valve, then repeat steps 11-15.
18. Inspect the brake booster check valve grommet for the following conditions:
 - Loose connection to the vacuum brake booster
 - Deformation or contamination
 - Cracks, cuts, dry-rot
19. If any of these conditions were found with the check valve grommet, replace the grommet.

BRAKE SYSTEM EXTERNAL LEAK INSPECTION

CAUTION: Refer to Brake Fluid Irritant Caution .

NOTE: Refer to Brake Fluid Effects on Paint and Electrical Components Notice .

1. In order to inspect for external brake fluid leaks, first check the fluid level in the master cylinder.

While a slight brake fluid level drop can be considered a normal condition due to brake lining wear, a very low level may indicate a brake fluid leak in the hydraulic system.

2. If the fluid level is abnormally low, adjust the brake fluid level. Refer to Master Cylinder Reservoir Filling.
3. Start the engine and allow it to idle.
4. Apply constant, moderate foot pressure to the brake pedal.

If the brake pedal gradually falls away while under foot pressure, there may be a brake fluid leak.

5. Turn OFF the ignition.

6. Visually inspect the following brake system components for brake fluid leaks, excessive corrosion and damage. Give particular attention to all brake pipe and flexible hose connections to ensure that there are not any slight brake fluid leaks - even though the brake pedal may feel firm and hold steady:
 - Master cylinder brake pipe fittings
 - All brake pipe connections
 - Brake pipes
 - Brake hoses and connections
 - Brake calipers and/or wheel cylinders, if equipped
7. While slight dampness around the master cylinder reservoir can be considered acceptable, brake fluid leaking from any of the brake system components requires immediate attention. If any of these components exhibit signs of brake fluid leakage, repair or replace those components. After the repair or replacement, reinspect the hydraulic brake system to assure proper function.

BRAKE SYSTEM INTERNAL LEAK TEST

CAUTION: Refer to Brake Fluid Irritant Caution .

NOTE: Refer to Brake Fluid Effects on Paint and Electrical Components Notice .

1. Start the engine and allow it to idle.
2. Apply light, steady pressure to the brake pedal. Observe both the brake pedal feel and travel.
3. Release the brakes and turn OFF the ignition.
4. If the brake pedal apply felt spongy, but the brake pedal travel was not excessive, perform the following steps:
 1. Inspect the brake system for external leaks. Refer to **Brake System External Leak Inspection** .
 2. Pressure bleed the brake system in order to purge any air that may be trapped in the system. Refer to **Hydraulic Brake System Bleeding (Manual)** and **Hydraulic Brake System Bleeding (Pressure)**.

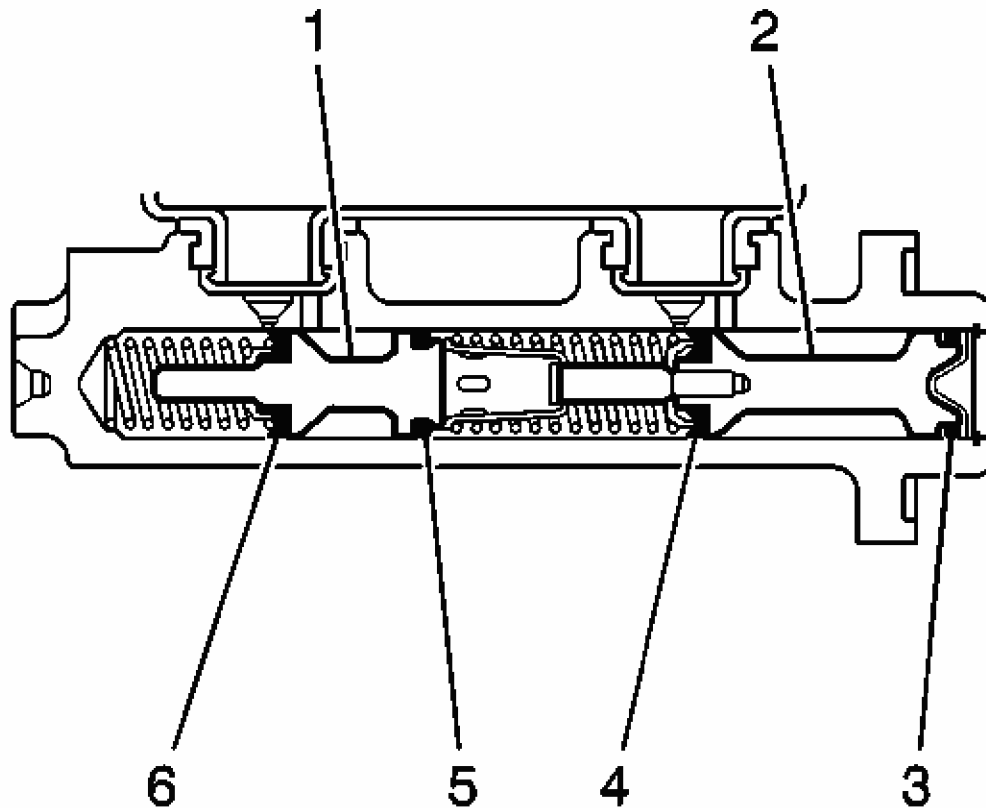


Fig. 7: Cross Sectional View Of Brake Master Cylinder
Courtesy of GENERAL MOTORS CORP.

5. If the brake pedal apply did not feel spongy, but the brake pedal travel was excessive, perform the following steps:
 1. Loosen the master cylinder-to-brake power booster mounting nuts.
 2. Carefully pull the master cylinder away from the brake power booster just enough to inspect the mounting surface of the master cylinder.
 3. Inspect the master cylinder mounting surface at the primary piston (2) for brake fluid leaks.
6. If the master cylinder exhibits any leakage around the primary piston (2), then the primary piston primary seal (4) and/or secondary seal (3) is leaking and the master cylinder requires overhaul or replacement.
7. If the master cylinder primary piston (2) does not exhibit any leakage, pressure bleed the brake system. Refer to **Hydraulic Brake System Bleeding (Manual)** or **Hydraulic Brake System Bleeding (Pressure)**.

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8. If the brake pedal apply did not feel spongy and the brake pedal travel was initially steady and not excessive, but then gradually fell, then the master cylinder requires overhaul or replacement due to an internal leak past the secondary piston (1) from the secondary piston primary seal (6) or secondary seal (5).
9. If the brake pedal apply did not feel spongy and the brake pedal travel was initially steady and not excessive, then fell slightly, then became steady again, then the brake pressure modulator valve (BPMV) may be leaking internally and may require replacement.

HYDRAULIC BRAKE COMPONENT OPERATION VISUAL INSPECTION

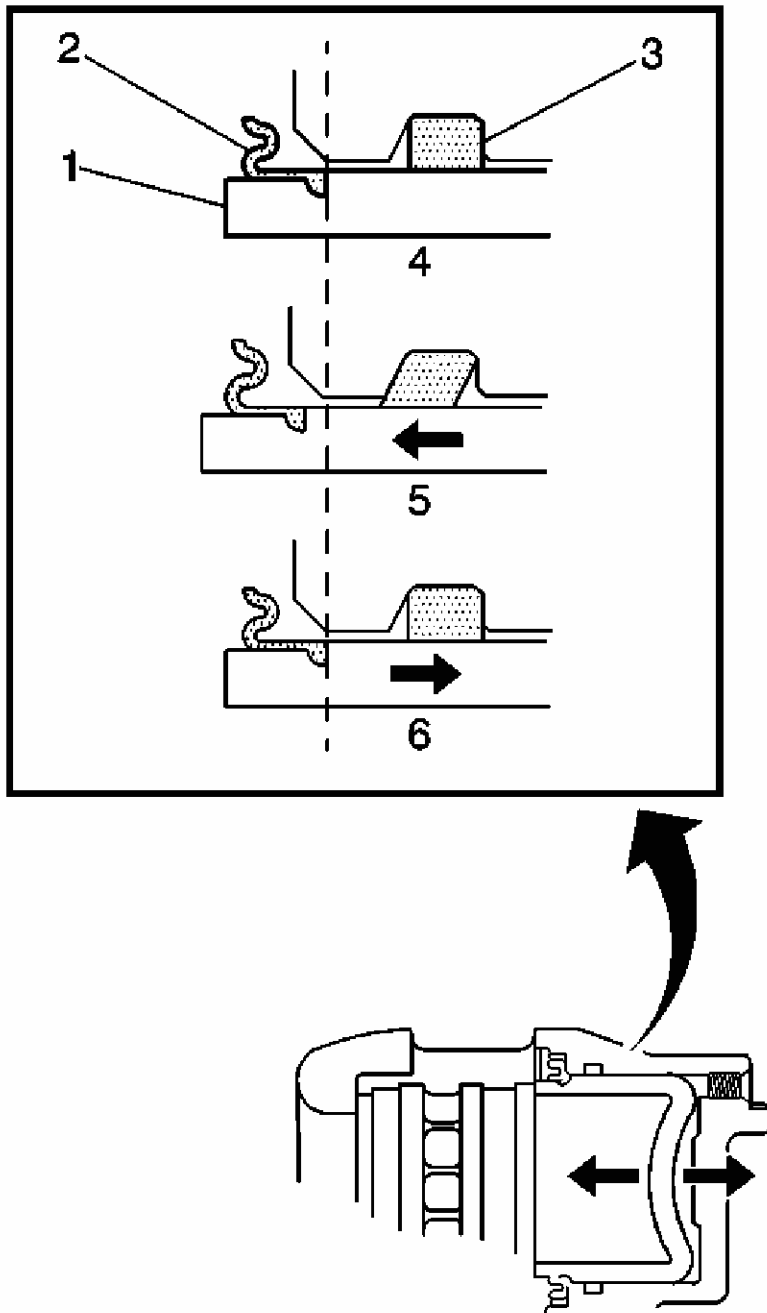


Fig. 8: Identifying Brake Caliper/Pad Inspection Areas
Courtesy of GENERAL MOTORS CORP.

CAUTION: Refer to Brake Fluid Irritant Caution .

NOTE: **Refer to Brake Fluid Effects on Paint and Electrical Components Notice .**

1. With the tire and wheel assemblies removed and the brake rotors retained by wheel lug nuts, visually inspect the caliper piston dust boot (2) sealing area to ensure that there are no brake fluid leaks.
2. If any evidence of a brake fluid leak is present, the brake caliper requires overhaul or replacement.
3. While the brake system is at rest (4), observe the position of the caliper piston (1) in relation to the caliper housing.
4. Have an assistant apply and release the brake pedal several times while you observe the operation of the hydraulic brake caliper.
 1. Observe the caliper piston (1) for unrestricted and even movement during each apply of the brake system (5).
 2. Observe the caliper piston (1) for an unrestricted and even return motion during each release of the brake system (6).
5. If the caliper piston (1) did not exhibit unrestricted and even movement during brake system apply and/or release, the piston square seal (3) may be worn or damaged and the caliper may require overhaul or replacement.

BRAKE PIPE AND HOSE INSPECTION

CAUTION: **Refer to Brake Fluid Irritant Caution .**

NOTE: **Refer to Brake Fluid Effects on Paint and Electrical Components Notice .**

1. Visually inspect all of the brake pipes for the following conditions:
 - Kinks, improper routing, missing or damaged retainers
 - Leaking fittings, excessive corrosion
2. If any of the brake pipes exhibited any of the conditions listed, then the identified pipe or pipes, require replacement.
3. Ensure that the vehicle axles are properly supported at ride height in order to maintain the proper relationship of the flexible brake hoses to the chassis.

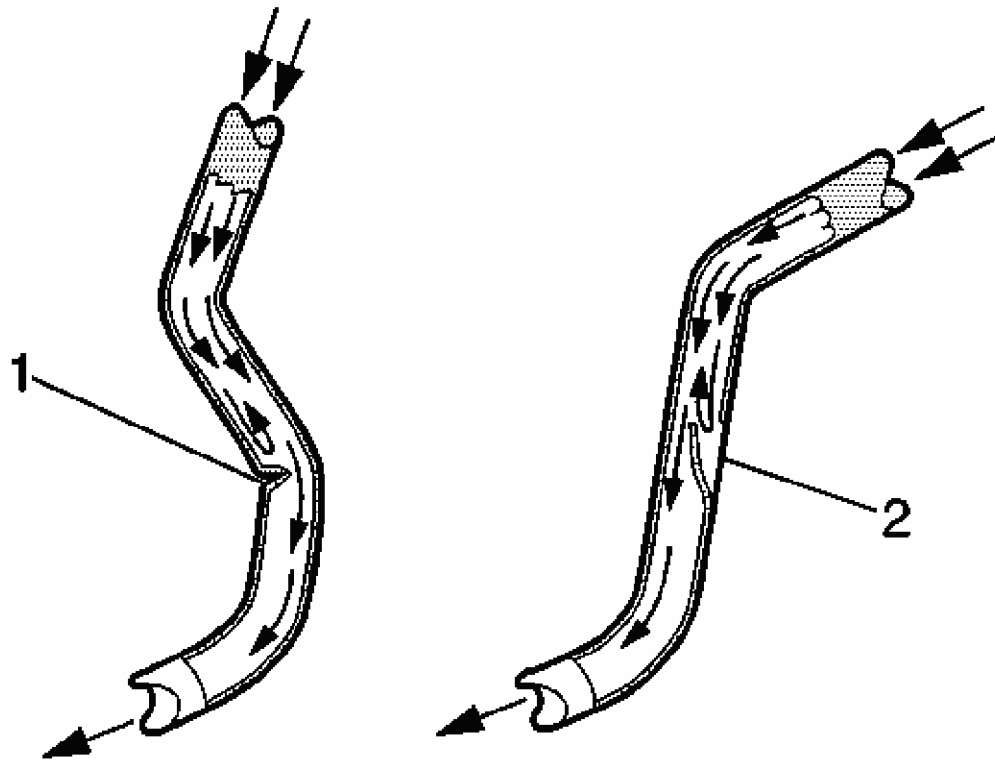


Fig. 9: Identifying Flexible Brake Hose Failure Conditions
Courtesy of GENERAL MOTORS CORP.

4. Visually inspect all of the flexible brake hoses for the following conditions:
 - Kinks (1), improper routing, twists, chafing, missing or damaged retainers
 - Leaking connections, cracking, dry-rot, blisters, bulges
5. If any of the flexible brake hoses exhibited any of the conditions listed, then the identified flexible brake hose or hoses require replacement.
6. Squeeze the flexible brake hoses with firm finger pressure to check for soft spots (2), indicating an internal restriction. Check the entire length of each flexible brake hose.
7. If any of the flexible brake hoses were found to have soft spots (2), then the identified flexible brake hose or hoses require replacement.

BRAKE PEDAL PUSHROD INSPECTION

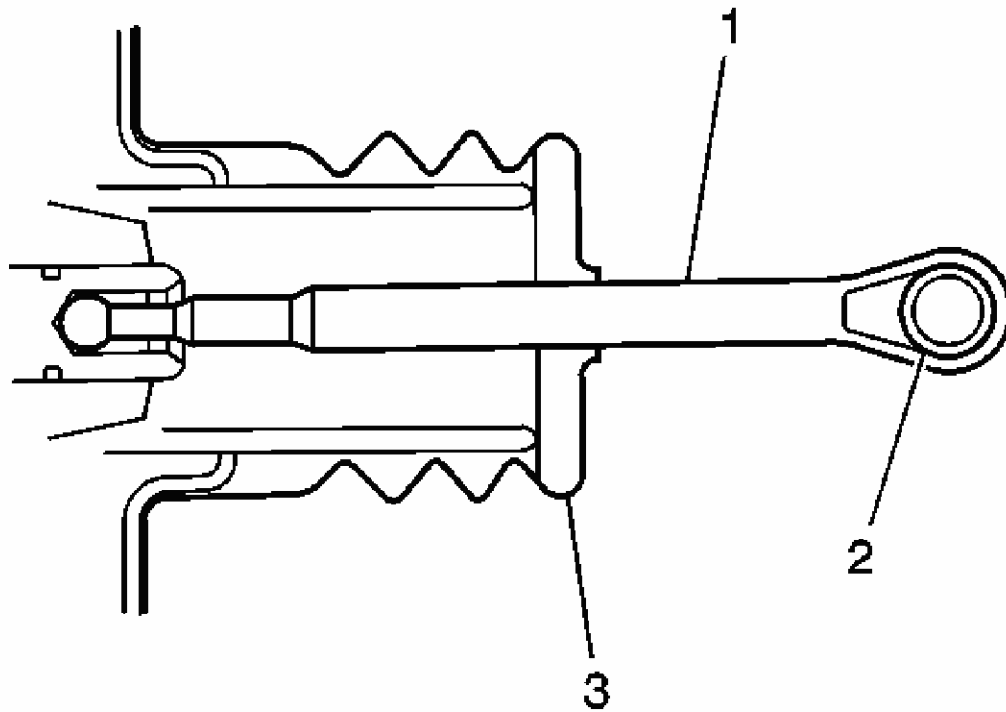


Fig. 10: View of Brake Pedal Pushrod
Courtesy of GENERAL MOTORS CORP.

1. Disconnect the brake pedal pushrod (1) from the brake pedal.
2. Inspect the brake pedal pushrod eyelet bushing (2), if equipped, for cracks and/or excessive wear.
3. Reposition the pedal pushrod boot (3) toward the front of the vehicle to expose as much of the pedal pushrod (1) as possible.
4. Inspect the brake pedal pushrod (1) for straightness.
5. If the brake pedal pushrod eyelet bushing (2) exhibited cracks and/or excessive wear, then the bushing requires replacement.
6. If the brake pedal pushrod (1) is not straight, then the pushrod requires replacement.
7. Return the pedal pushrod boot (3) to its original position on the pedal pushrod (1).
8. Connect the brake pedal pushrod (1) to the brake pedal.

REPAIR INSTRUCTIONS

MASTER CYLINDER RESERVOIR FILLING

CAUTION: Refer to Brake Fluid Irritant Caution .

NOTE: When adding fluid to the brake master cylinder reservoir, use only Delco Supreme 11®, GM P/N 12377967 (Canadian P/N 992667) or equivalent DOT-3 brake fluid from a clean, sealed brake fluid container. The use of any type of fluid other than the recommended type of brake fluid, may cause contamination which could result in damage to the internal rubber seals and/or rubber linings of hydraulic brake system components.

NOTE: Refer to Brake Fluid Effects on Paint and Electrical Components Notice .

1. Visually inspect the brake fluid level through the brake master cylinder reservoir.
2. If the brake fluid level is at or below the half-full point during routine fluid checks, the brake system should be inspected for wear and possible brake fluid leaks.
3. If the brake fluid level is at or below the half-full point during routine fluid checks and an inspection of the brake system did not reveal wear or brake fluid leaks, the brake fluid may be topped-off up to the maximum-fill level.
4. If brake system service was just completed, the brake fluid may be topped-off up to the maximum-fill level.
5. If the brake fluid level is above the half-full point, adding brake fluid is not recommended under normal conditions.
6. If brake fluid is to be added to the master cylinder reservoir, clean the outside of the reservoir on and around the reservoir cap prior to removing the cap and diaphragm. Use only Delco Supreme 11®, GM P/N 12377967 (Canadian P/N 992667) or equivalent DOT-3 brake fluid from a clean, sealed brake fluid container.

MASTER CYLINDER RESERVOIR REPLACEMENT

CAUTION: Refer to Brake Fluid Irritant Caution .

NOTE: Refer to Brake Fluid Effects on Paint and Electrical Components Notice .

Removal Procedure

1. Remove the master cylinder from the vehicle. Refer to Master Cylinder Replacement.

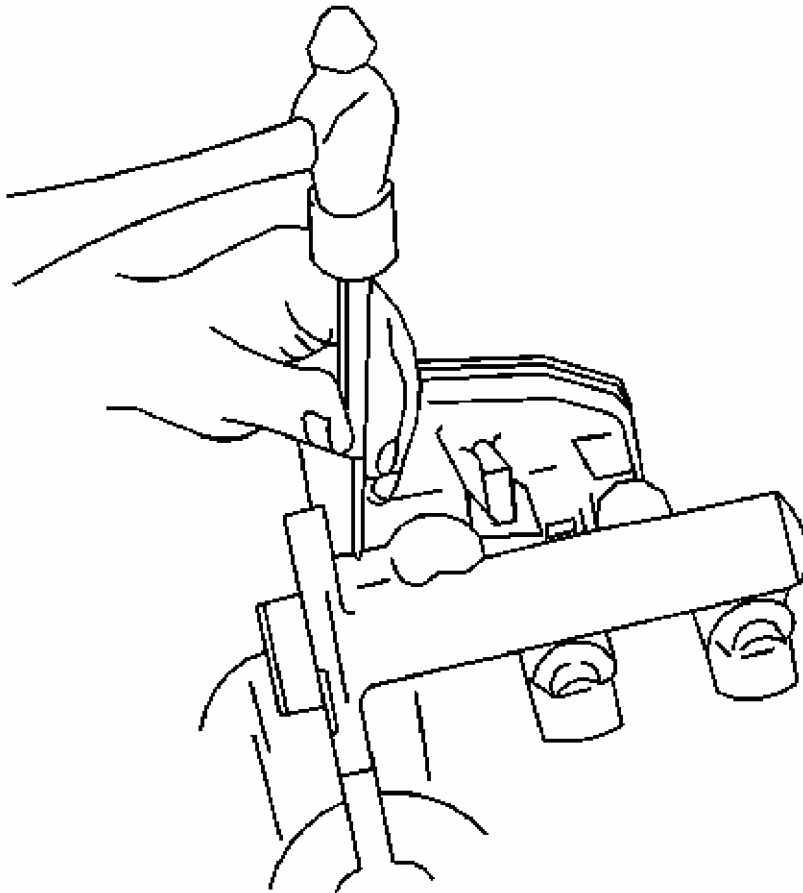


Fig. 11: Removing/Installing Reservoir Retaining Pins
Courtesy of GENERAL MOTORS CORP.

2. Remove the fluid level sensor. Refer to **Brake Fluid Level Indicator Switch Replacement**.
3. Drain the brake fluid from the master cylinder reservoir.
4. Carefully tap out the reservoir retaining pins until clear of reservoir.
5. Remove the reservoir from the master cylinder.
6. Remove the seals from the master cylinder reservoir.

Installation Procedure

1. Inspect the reservoir for cracks or deformities. If found, replace the reservoir.
2. Clean the reservoir with clean denatured alcohol or equivalent.

3. Dry the reservoir with non-lubricated, filtered air.

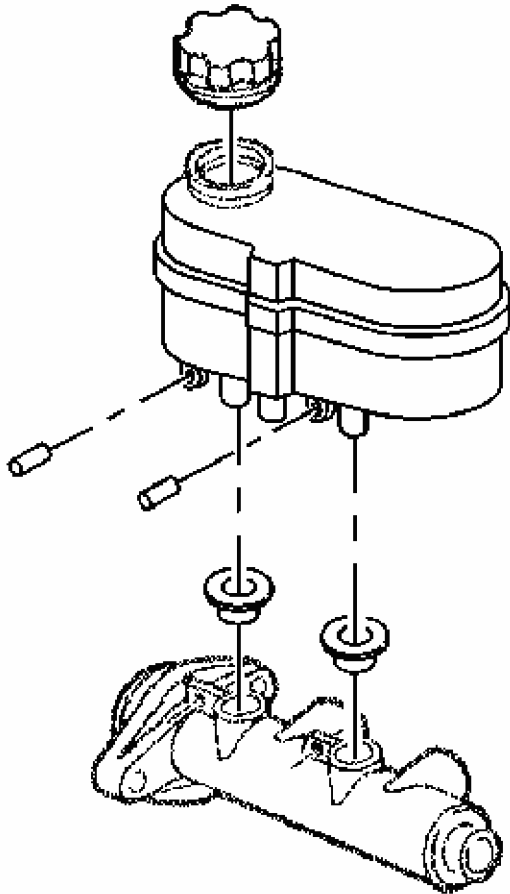


Fig. 12: Installing Reservoir Onto Master Cylinder
Courtesy of GENERAL MOTORS CORP.

4. Lubricate the new seals and the reservoir bayonets with new Delco Supreme 11®, GM P/N 12377967 (Canadian P/N 992667) or equivalent DOT-3 brake fluid.
5. Install the seals, making sure they are fully seated.
6. Install the reservoir onto the master cylinder by pressing straight down by hand until pin holes are aligned.

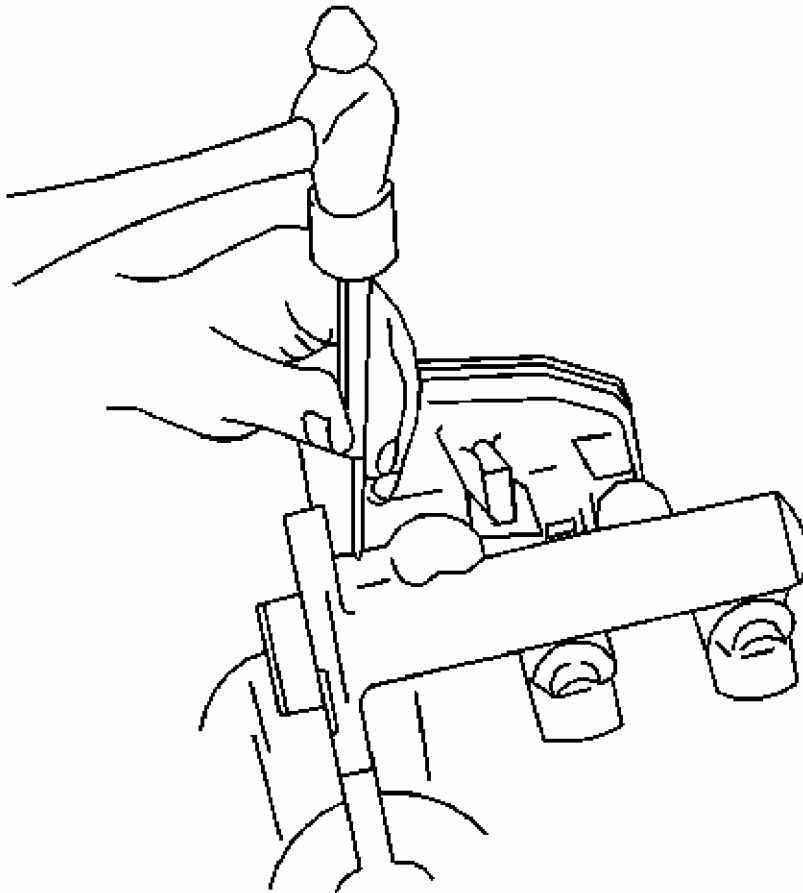


Fig. 13: Removing/Installing Reservoir Retaining Pins
Courtesy of GENERAL MOTORS CORP.

7. Carefully tap in the reservoir retaining pins to secure the reservoir.
8. Fill the master cylinder reservoir. Refer to **Master Cylinder Reservoir Filling**.
9. Install the brake fluid level sensor. Refer to **Brake Fluid Level Indicator Switch Replacement**.
10. Install the master cylinder to the vehicle. Refer to **Master Cylinder Replacement**.

MASTER CYLINDER REPLACEMENT

CAUTION: Refer to in **Brake Fluid Irritant Caution** .

NOTE: Refer to Brake Fluid Effects on Paint and Electrical Components Notice .

Removal Procedure

1. Disconnect the electrical connector from the brake fluid level sensor.
2. Disconnect the brake pipes from the master cylinder.

IMPORTANT: Install a rubber cap or plug to the exposed brake pipe fitting end in order to prevent brake fluid loss and contamination.

3. Plug the open brake pipe fitting ends.

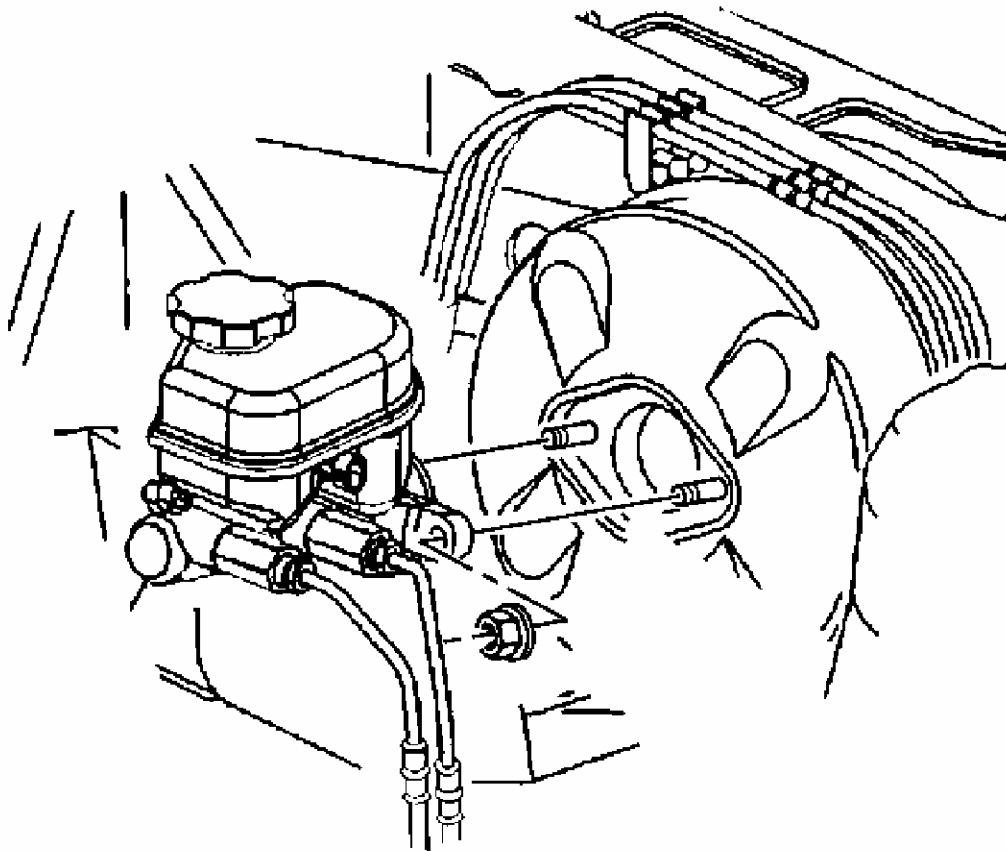


Fig. 14: Removing & Installing Master Cylinder
Courtesy of GENERAL MOTORS CORP.

4. Remove the 2 master cylinder mounting nuts.
5. Remove the master cylinder.
6. Remove the reservoir from the master cylinder if it is to be reused on a replacement master cylinder. Refer to **Master Cylinder Reservoir Replacement**.

Installation Procedure

1. Install the brake master cylinder reservoir to the master cylinder if it was removed previously. Refer to **Master Cylinder Reservoir Replacement**.
2. Bench bleed the master cylinder. Refer to **Master Cylinder Bench Bleeding**.

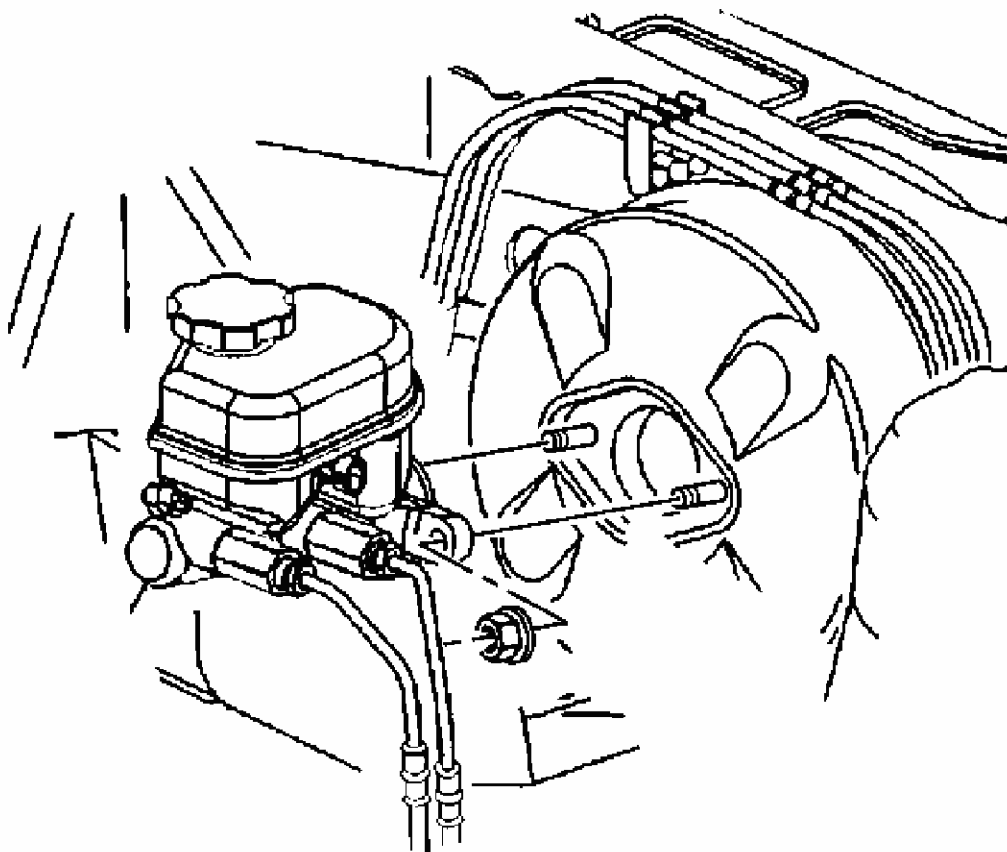


Fig. 15: Removing & Installing Master Cylinder
Courtesy of GENERAL MOTORS CORP.

3. Install the master cylinder to the vacuum brake booster.

NOTE: Refer to Fastener Notice .

4. Install the 2 brake master cylinder mounting nuts.

Tighten: Tighten the 2 brake master cylinder mounting nuts to 30 N.m (22 lb ft).

5. Remove the plugs from the brake pipes.
6. Install the brake pipes to the master cylinder.

Tighten: Tighten the brake pipe fittings at the master cylinder to 29 N.m (21 lb ft).

7. Connect the electrical connector to the brake fluid level sensor.
8. Bleed the hydraulic brake system. Refer to **Hydraulic Brake System Bleeding (Manual)** or **Hydraulic Brake System Bleeding (Pressure)**.

MASTER CYLINDER BENCH BLEEDING

CAUTION: Refer to **Brake Fluid Irritant Caution** .

NOTE: Refer to **Brake Fluid Effects on Paint and Electrical Components Notice** .

NOTE: When adding fluid to the brake master cylinder reservoir, use only Delco Supreme 11®, GM P/N 12377967 (Canadian P/N 992667) or equivalent DOT-3 brake fluid from a clean, sealed brake fluid container. The use of any type of fluid other than the recommended type of brake fluid, may cause contamination which could result in damage to the internal rubber seals and/or rubber linings of hydraulic brake system components.

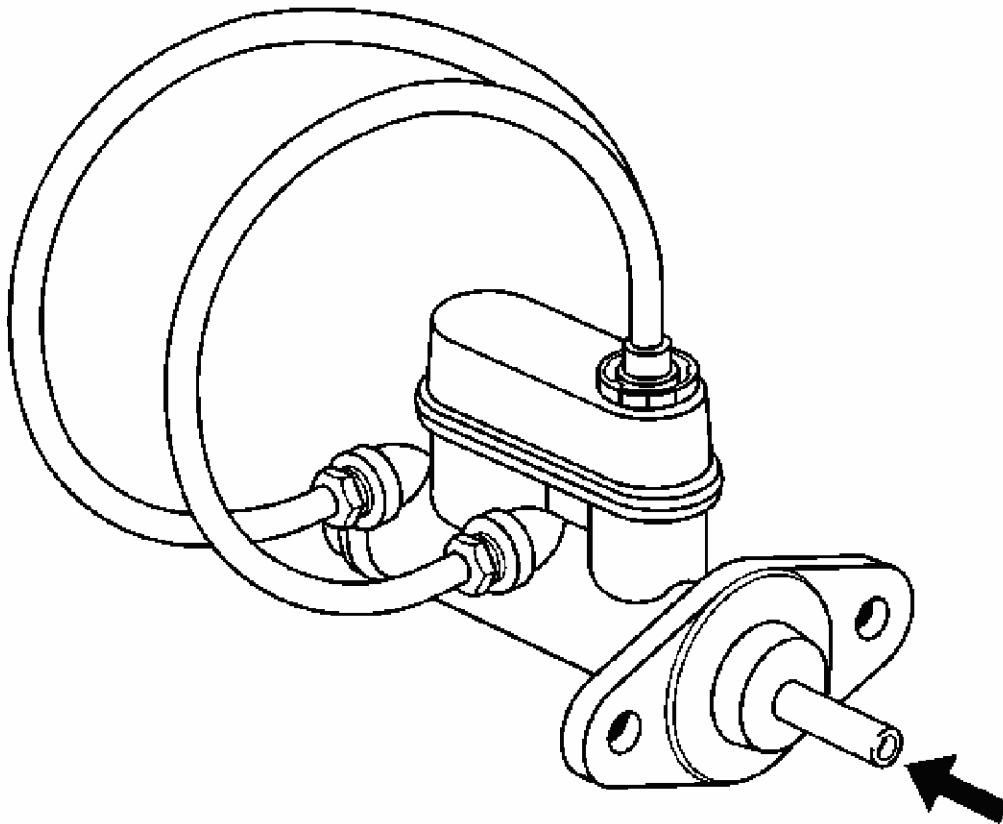


Fig. 16: Bleeding Master Cylinder
Courtesy of GENERAL MOTORS CORP.

1. Secure the mounting flange of the brake master cylinder in a bench vise so that the rear of the primary piston is accessible.
2. Remove the master cylinder reservoir cap and diaphragm.
3. Install suitable fittings to the master cylinder ports that match the type of flare seat required and also provide for hose attachment.
4. Install transparent hoses to the fittings installed to the master cylinder ports, then route the hoses into the master cylinder reservoir.
5. Fill the master cylinder reservoir to at least the half-way point with Delco Supreme 11®, GM P/N 12377967 (Canadian P/N 992667) or equivalent DOT-3 brake fluid from a clean, sealed brake fluid container.
6. Ensure that the ends of the transparent hoses running into the master cylinder reservoir are fully submerged in the brake fluid.
7. Using a smooth, round-ended tool, depress and release the primary piston as far as it will

travel, a depth of about 25 mm (1 in), several times. Observe the flow of fluid coming from the ports.

As air is bled from the primary and secondary pistons, the effort required to depress the primary piston will increase and the amount of travel will decrease.

8. Continue to depress and release the primary piston until fluid flows freely from the ports with no evidence of air bubbles.
9. Remove the transparent hoses from the master cylinder reservoir.
10. Install the master cylinder reservoir cap and diaphragm.
11. Remove the fittings with the transparent hoses from the master cylinder ports. Wrap the master cylinder with a clean shop cloth to prevent brake fluid spills.
12. Remove the master cylinder from the vise.

BRAKE FLUID LEVEL INDICATOR SWITCH REPLACEMENT

CAUTION: Refer to Brake Fluid Irritant Caution .

NOTE: Refer to Brake Fluid Effects on Paint and Electrical Components Notice .

Removal Procedure

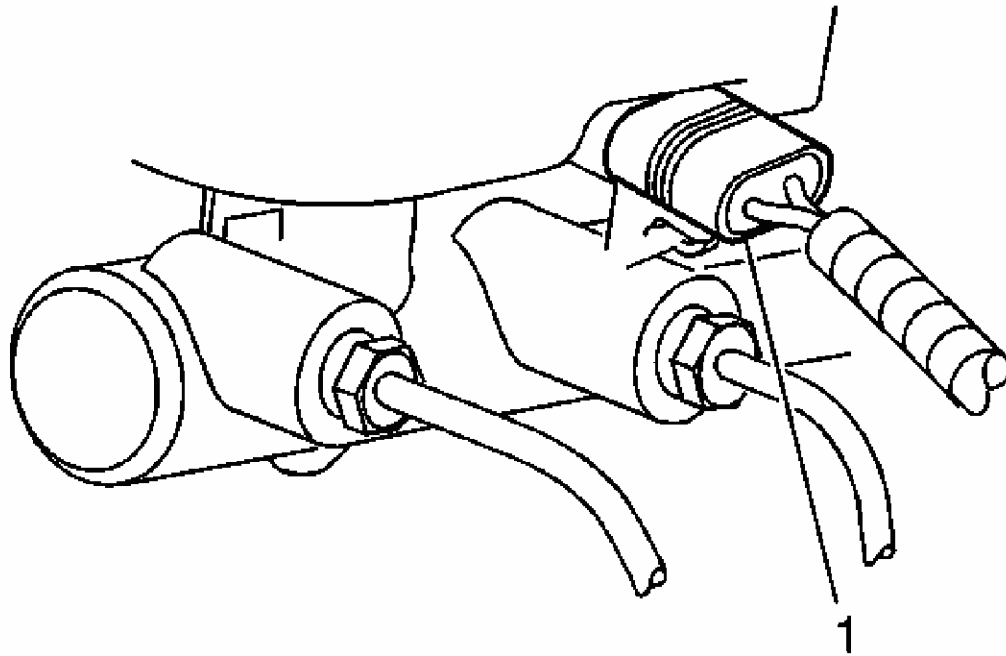


Fig. 17: View Of Brake Fluid Level Sensor Electrical Connector
Courtesy of GENERAL MOTORS CORP.

1. Disconnect the electrical connector (1) from the brake fluid level sensor.

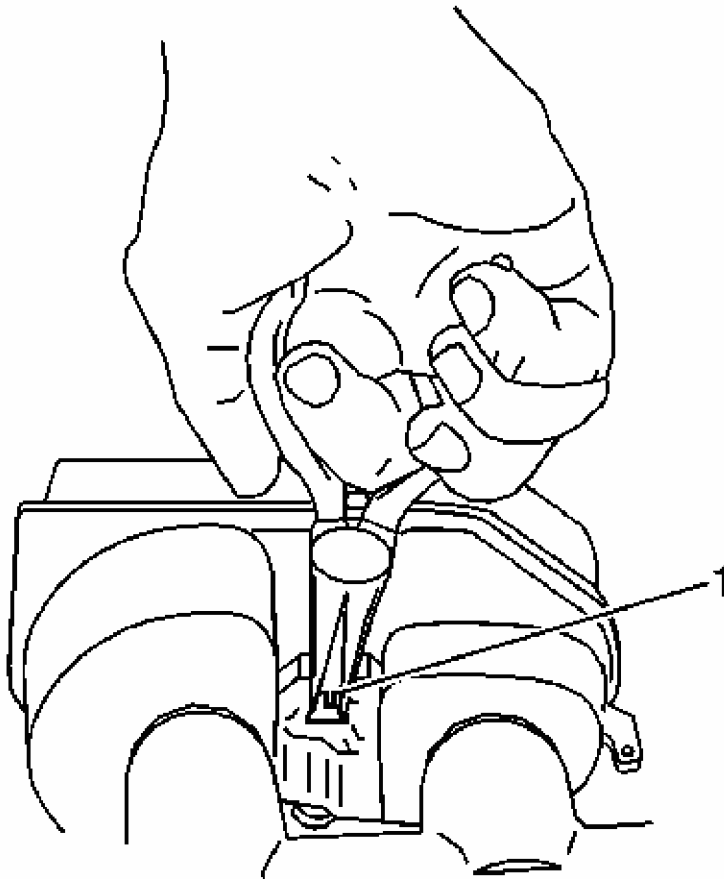


Fig. 18: Removing Brake Fluid Level Sensor
Courtesy of GENERAL MOTORS CORP.

2. Using a needle nose pliers carefully depress the retaining tabs (1) on the end of the brake fluid level sensor and press the sensor through the reservoir to remove.

Installation Procedure

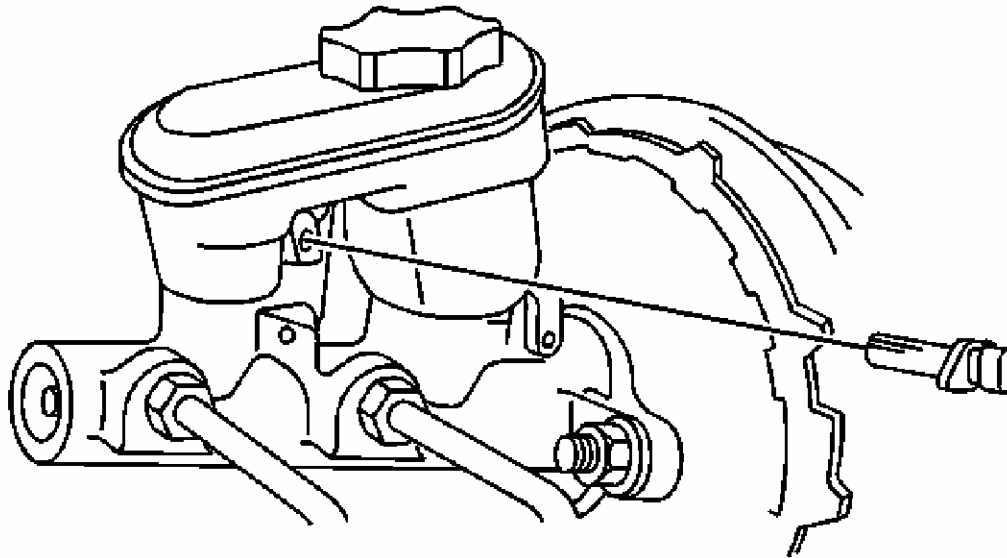


Fig. 19: Installing Brake Fluid Level Sensor
Courtesy of GENERAL MOTORS CORP.

1. Align the brake fluid level sensor to the master cylinder reservoir.
2. Press the brake fluid level sensor into the master cylinder reservoir.
3. Connect the electrical connector to the brake fluid level sensor.

BRAKE PEDAL ASSEMBLY REPLACEMENT

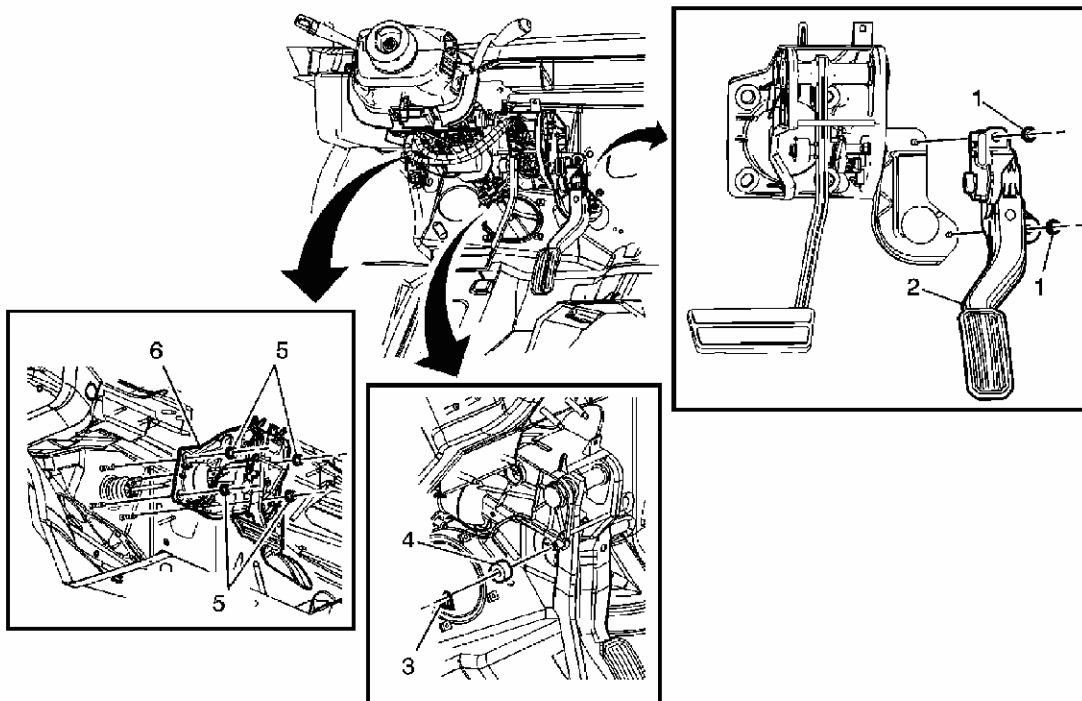


Fig. 20: Replacing Brake Pedal Assembly
Courtesy of GENERAL MOTORS CORP.

Brake Pedal Assembly Replacement

Callout	Component Name
<p>NOTE: Refer to <u>Fastener Notice</u> .</p> <p>Fastener Tightening Specifications: Refer to <u>Fastener Tightening Specifications</u>.</p> <p>Preliminary Procedure</p> <ol style="list-style-type: none"> 1. Remove the knee bolster panel. Refer to <u>Driver Knee Bolster Replacement</u> . 2. Disconnect the electrical connector from the brake pedal position sensor. 	
1	<p>Nut (Qty: 2)</p> <p>Tighten: 10 N.m (89 lb in)</p>
2	<p>Accelerator Pedal</p> <p>Tip:</p> <ul style="list-style-type: none"> • Release the wiring harness retainer from the brake pedal bracket. • Relocate accelerator pedal to the side.
3	<p>Clip</p>

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4	Spacer Tip: Apply silicone brake lubricant to the brake pedal pushrod pivot pin.
5	Nut (Qty: 4) Tip: <ol style="list-style-type: none">1. Lower the steering column. Refer to <u>Steering Column Replacement</u> .2. You DO NOT have to remove the steering column from the vehicle. Lower the steering column to gain access to the mounting bolts for the brake pedal mounting bracket. Tighten: 30 N.m (22 lb ft)
6	Brake Pedal Tip: Re-calibrate the brake pedal position sensor. Refer to <u>Brake Pedal Position Sensor Calibration</u> .

BRAKE PIPE REPLACEMENT

Tools Required

J 45405 Pipe Flaring Tool Kit. See **Special Tools**.

CAUTION: Refer to **Brake Fluid Irritant Caution** .

CAUTION: Always use double walled steel brake pipe when replacing brake pipes. The use of any other pipe is not recommended and may cause brake system failure. Carefully route and retain replacement brake pipes. Always use the correct fasteners and the original location for replacement brake pipes. Failure to properly route and retain brake pipes may cause damage to the brake pipes and cause brake system failure.

NOTE: Refer to **Brake Fluid Effects on Paint and Electrical Components Notice** .

IMPORTANT: When servicing brake pipes, note the following:

- If sectioning brake pipe, use replacement pipe of the same type and outside diameter.

- Use fittings of the appropriate size and type.
- Only create flares of the same type or design as originally equipped on the vehicle.

Replacement Procedure

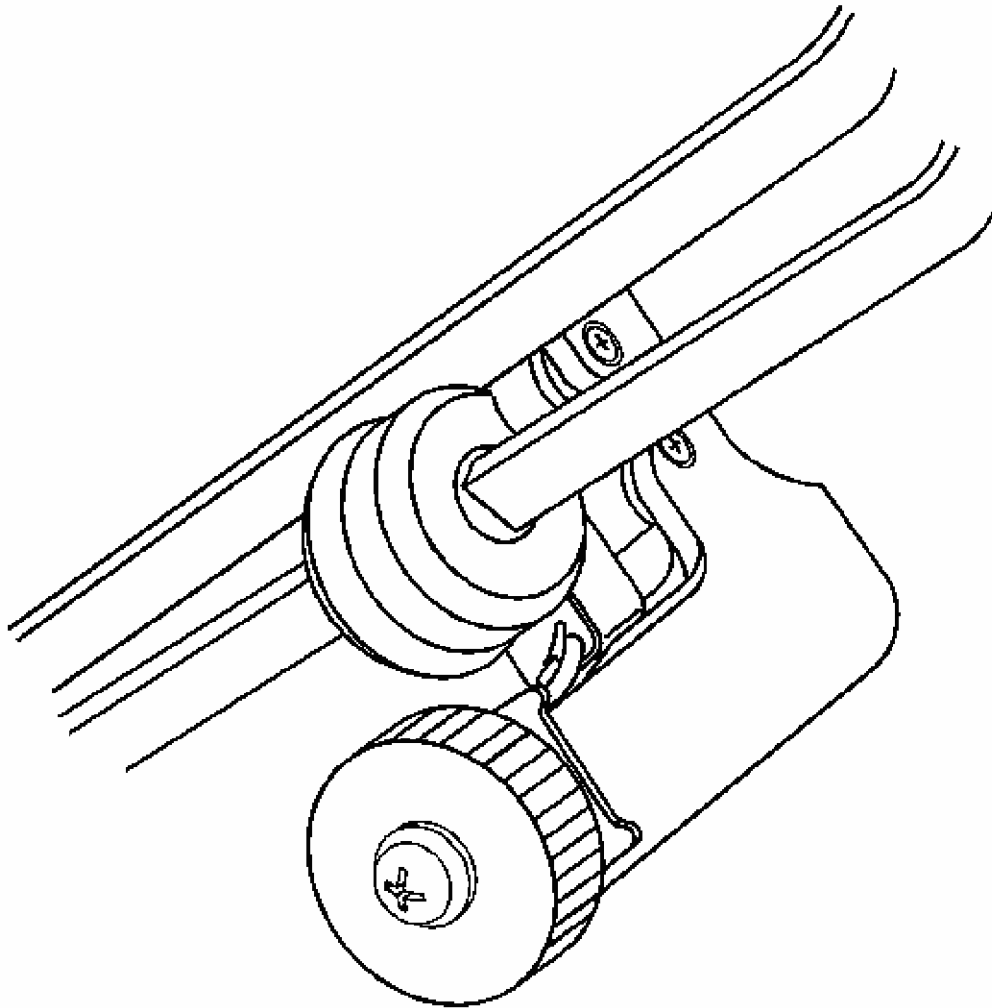


Fig. 21: Sectioning Brake Pipe Using Pipe Cutter
Courtesy of GENERAL MOTORS CORP.

1. Inspect the section of brake pipe to be replaced.
2. Release the brake pipe to be replaced from the retainers, as required.
3. Select an appropriate location to section the brake pipe, if necessary.

- Allow adequate clearance in order to maneuver the **J 45405** . See **Special Tools**.
 - Avoid sectioning the brake pipe at bends or mounting points.
4. Using a string or wire, measure the length of the pipe to be replaced including all pipe bends.
 5. Add to the measurement taken the appropriate additional length required for each flare to be created.

Specification: 6.35 mm (0.250 in) for 4.76 mm (3/16 in) diameter pipe

IMPORTANT: Ensure that the brake pipe end to be flared is cut at a square, 90 degree angle to the pipe length.

6. Using the pipe cutter included in the **J 45405** , carefully cut the brake pipe squarely to the measured length. See **Special Tools**.
7. Remove the sectioned brake pipe from the vehicle.
8. Select the appropriate size of brake pipe and tube nuts, as necessary. The brake pipe outside diameter determines brake pipe size.

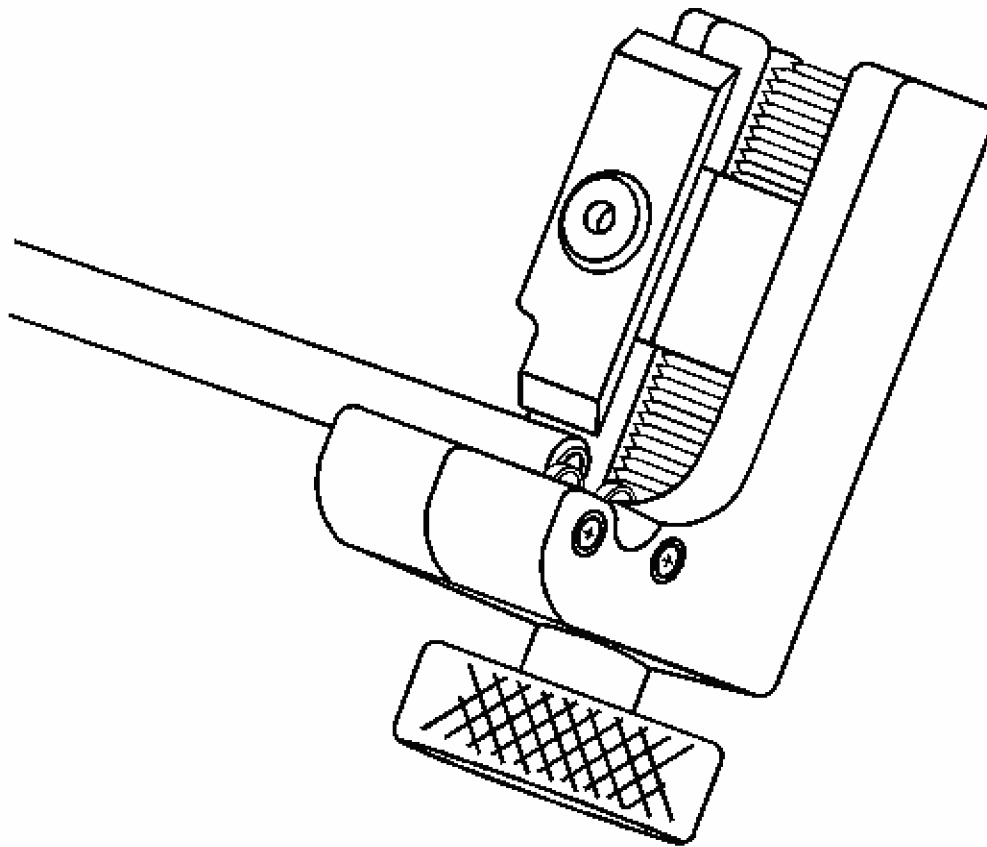


Fig. 22: Stripping Nylon Coating From Brake Pipe Ends

Courtesy of GENERAL MOTORS CORP.

9. Strip the nylon coating from the brake pipe ends to be flared, if necessary.
 - Select the appropriate blade on the coating stripping tool included in the **J 45405** , by unthreading the blade block from the stripping tool and installing the block with the desired blade facing the tool rollers. See **Special Tools**.

Specification: 6.35 mm (0.250 in) blade for 4.76 mm (3/16 in) diameter pipe

- Insert the brake pipe end to be flared into the stripping tool to the depth of the ledge on the tool rollers.
- While holding the brake pipe firmly against the stripping tool roller ledges, rotate the thumbwheel of the tool until the blade contacts the brake pipe coated surface.

IMPORTANT: Do not gouge the metal surface of the brake pipe.

- Rotate the stripping tool in a clockwise direction, ensuring that the brake pipe end remains against the tool roller ledges.
- After each successive revolution of the stripping tool, carefully rotate the thumbwheel of the tool clockwise, in order to continue stripping the coating from the brake pipe until the metal pipe surface is exposed.
- Loosen the thumbwheel of the tool and remove the brake pipe.

IMPORTANT: Ensure that all loose remnants of the nylon coating have been removed from the brake pipe.

- Inspect the stripped end of the brake pipe to ensure that the proper amount of coating has been removed.

Specification: 6.35 mm (0.250 in) for 4.76 mm (3/16 in) diameter pipe

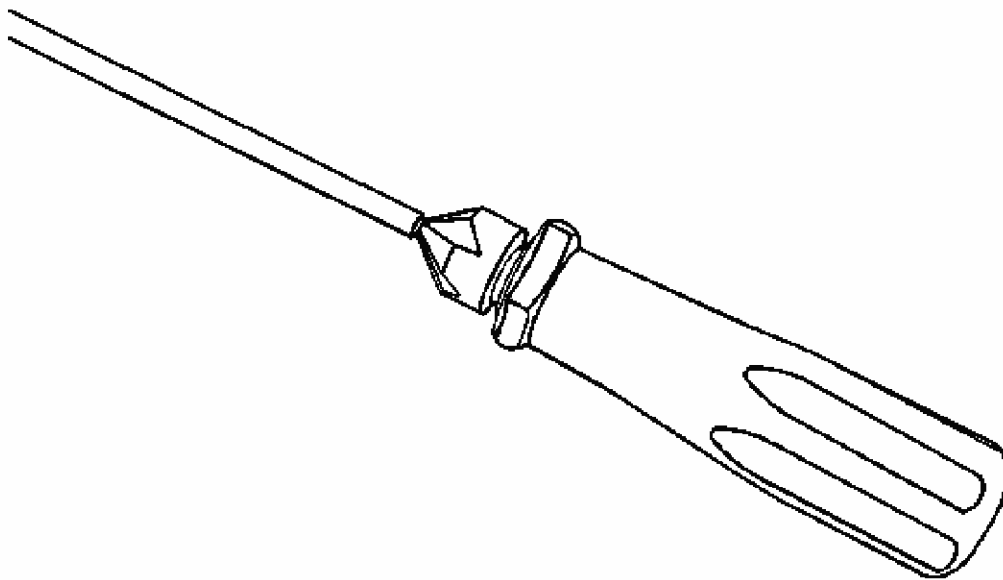


Fig. 23: Chamfering Pipe Using De-Burring Tool
Courtesy of GENERAL MOTORS CORP.

10. Chamfer the inside and outside diameter of the pipe with the de-burring tool included in the **J 45405** . See **Special Tools**.
11. Install the tube nuts on the brake pipe, noting their orientation.
12. Clean the brake pipe and the **J 45405** of lubricant, contaminants and debris. See **Special**

Tools.

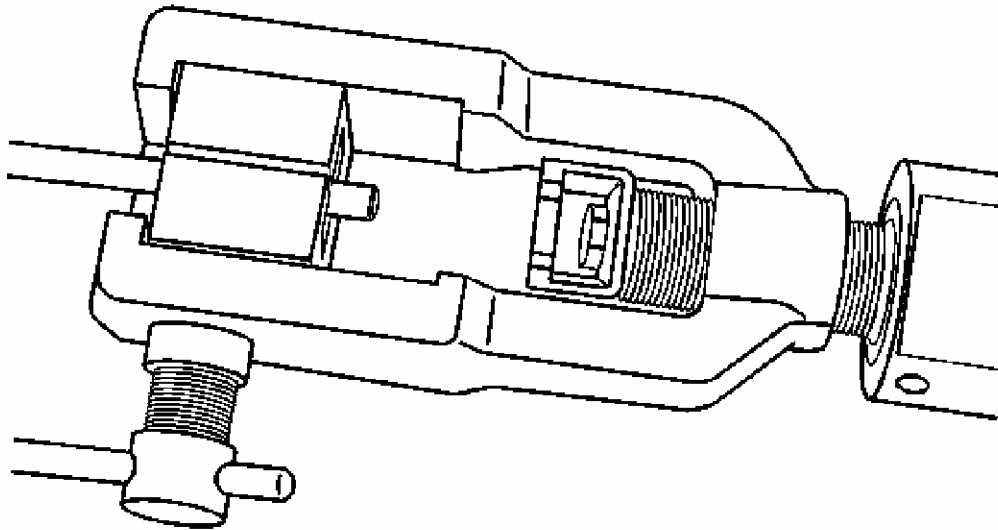


Fig. 24: Installing Die Halves Into Die Cage
Courtesy of GENERAL MOTORS CORP.

13. Loosen the die clamping screw of the **J 45405** . See **Special Tools**.
14. Select the corresponding die set and install the die halves into the die cage with the full, flat face of one die facing the clamping screw and the counterbores of both dies facing the forming ram.

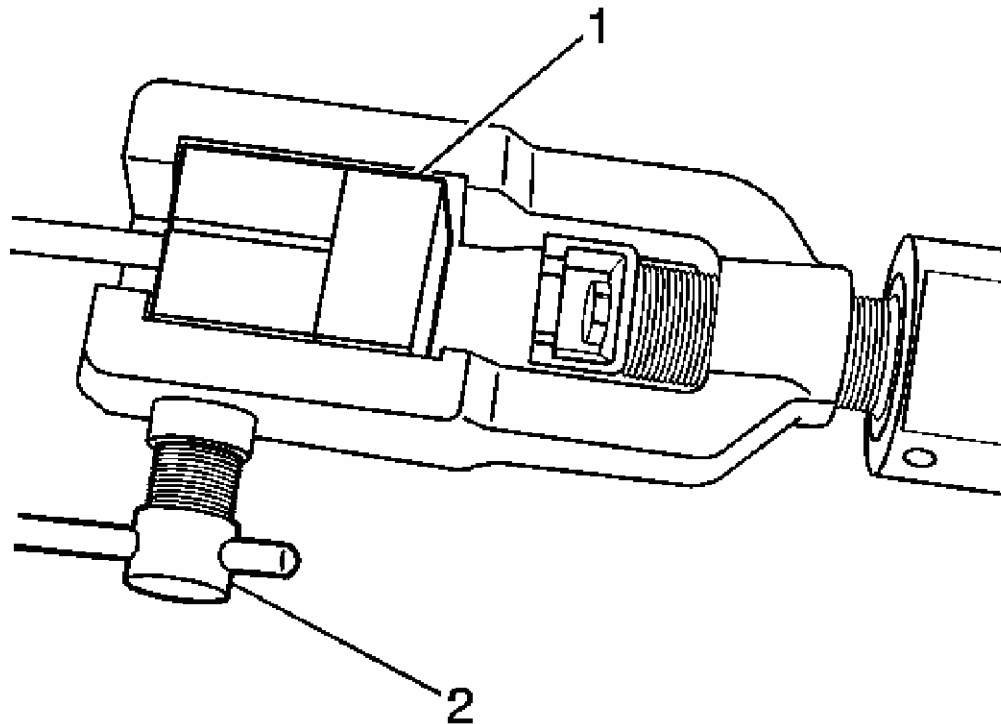


Fig. 25: View Of Clamping Screw & Unused Die
Courtesy of GENERAL MOTORS CORP.

15. Place the flat face of an unused die (1) against the die halves in the clamping cage and hold firmly against the counterbored face of the dies.
16. Insert the prepared end of the pipe to be flared through the back of the dies until the pipe is seated against the flat surface of the unused die (1).
17. Remove the unused die (1).
18. Ensure that the rear of both dies are seated firmly against the enclosed end of the die cage.
19. Firmly hand tighten the clamping screw (2) against the dies.

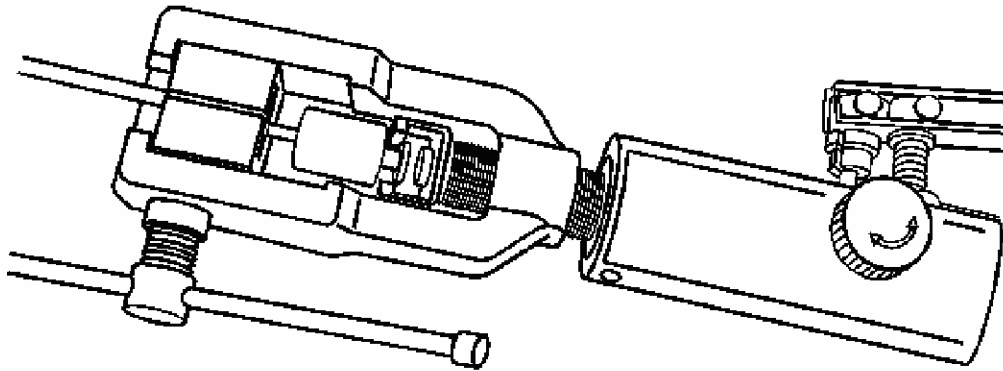


Fig. 26: Rotating J 45405 To Bottom Against Die Cage
Courtesy of GENERAL MOTORS CORP.

20. Select the appropriate forming mandrel and place into the forming ram.
21. Rotate the hydraulic fluid control valve clockwise to the closed position.
22. Rotate the body of the **J 45405** until it bottoms against the die cage. See **Special Tools**.

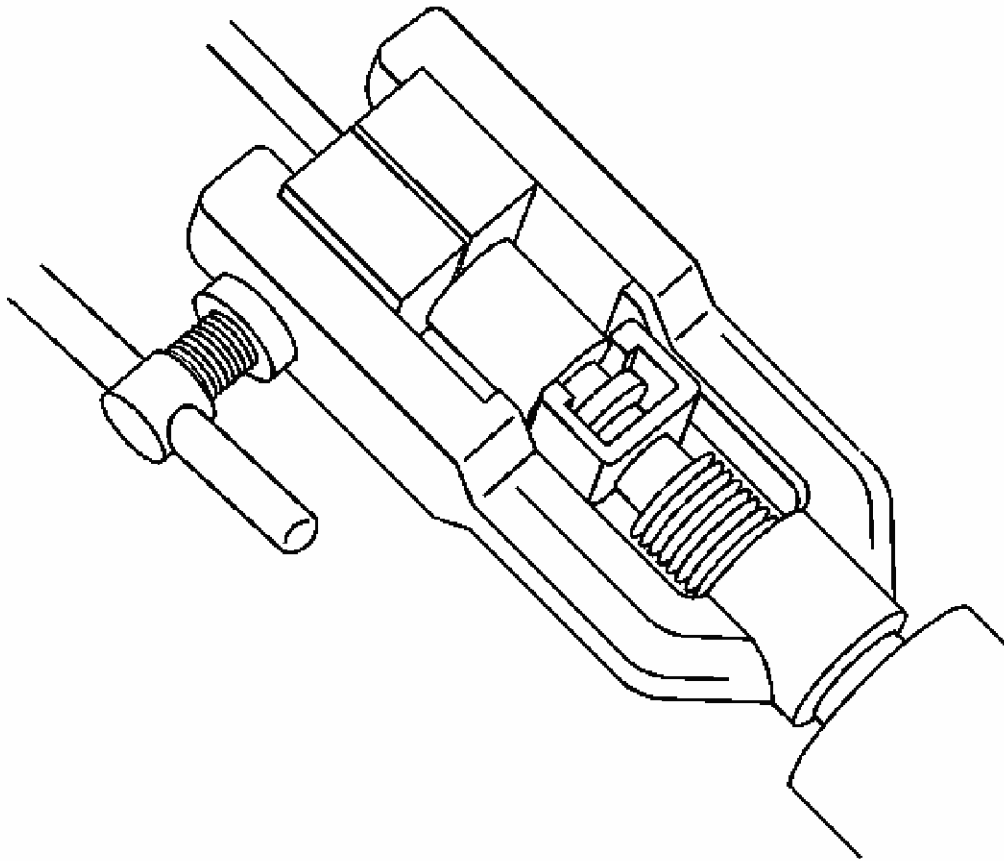


Fig. 27: Bottoming Forming Mandrel Against Clamping Dies Using Pipe Flaring Tool

Courtesy of GENERAL MOTORS CORP.

23. While guiding the forming mandrel into the exposed end of pipe to be flared, operate the lever of the **J 45405** until the forming mandrel bottoms against the clamping dies. See **Special Tools**.
24. Rotate the hydraulic fluid control valve counterclockwise to the open position to allow the hydraulic forming ram to retract.
25. Loosen the die clamping screw and remove the dies and pipe.
26. If necessary, lightly tap the dies until the die halves separate.

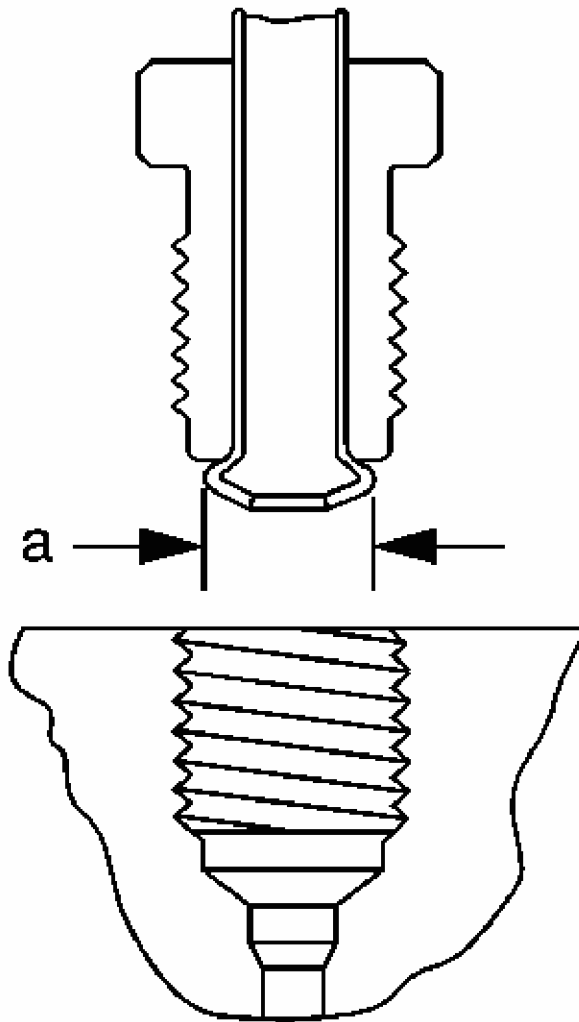


Fig. 28: Inspecting Brake Pipe Flare Diameter
Courtesy of GENERAL MOTORS CORP.

27. Inspect the brake pipe flare for correct shape and diameter (a).

Specification: 7.10 mm (0.279 in) +/- 0.18 mm (0.007 in) flare diameter for 4.76 mm (3/16 in) diameter pipe

28. If necessary, using the removed section of pipe as a template, shape the new pipe with a suitable brake pipe bending tool.

IMPORTANT: When installing the pipe, maintain a clearance of 19 mm

(3/4 in) from all moving or vibrating components.

29. Install the pipe to the vehicle with the appropriate brake pipe unions as required.
30. If previously released, secure the brake pipe to the retainers.
31. Bleed the hydraulic brake system. Refer to **Hydraulic Brake System Bleeding (Manual)** or **Hydraulic Brake System Bleeding (Pressure)**.
32. With the aid of an assistant, inspect the brake pipe flares for leaks by starting the engine and applying the brakes.

FRONT BRAKE HOSE REPLACEMENT

CAUTION: Refer to **Brake Fluid Irritant Caution** in Cautions and Notices.

NOTE: Refer to **Brake Fluid Effects on Paint and Electrical Components Notice** in Cautions and Notices.

Removal Procedure

1. Raise and suitably support the vehicle. Refer to **Lifting and Jacking the Vehicle** in General Information.
2. Remove the tire and wheel assembly. Refer to **Tire and Wheel Removal and Installation** in Tires and Wheels.
3. Clean all dirt and foreign material from the brake hose and the brake pipe fittings.

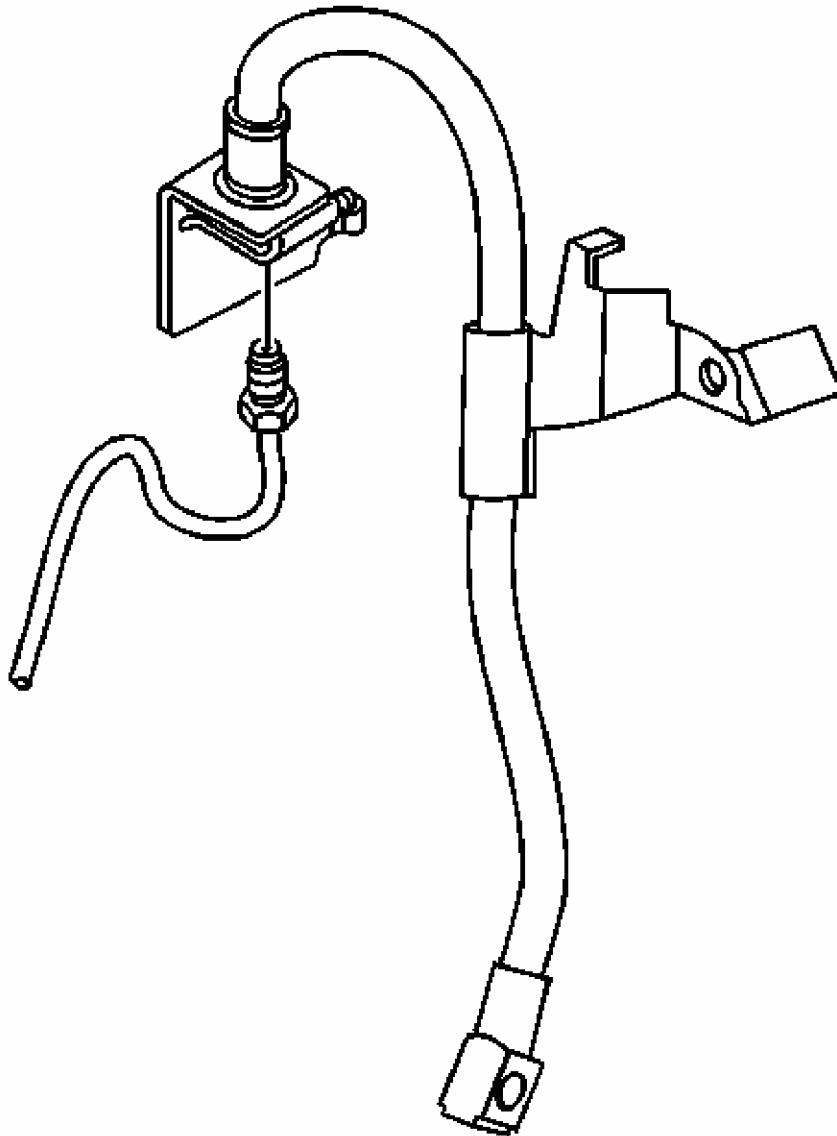


Fig. 29: Removing/Installing Brake Pipe Fitting To/From Brake Hose
Courtesy of GENERAL MOTORS CORP.

IMPORTANT: Install a rubber cap or plug to the exposed brake pipe fitting end in order to prevent brake fluid loss and contamination.

4. Remove the brake pipe fitting from the brake hose.

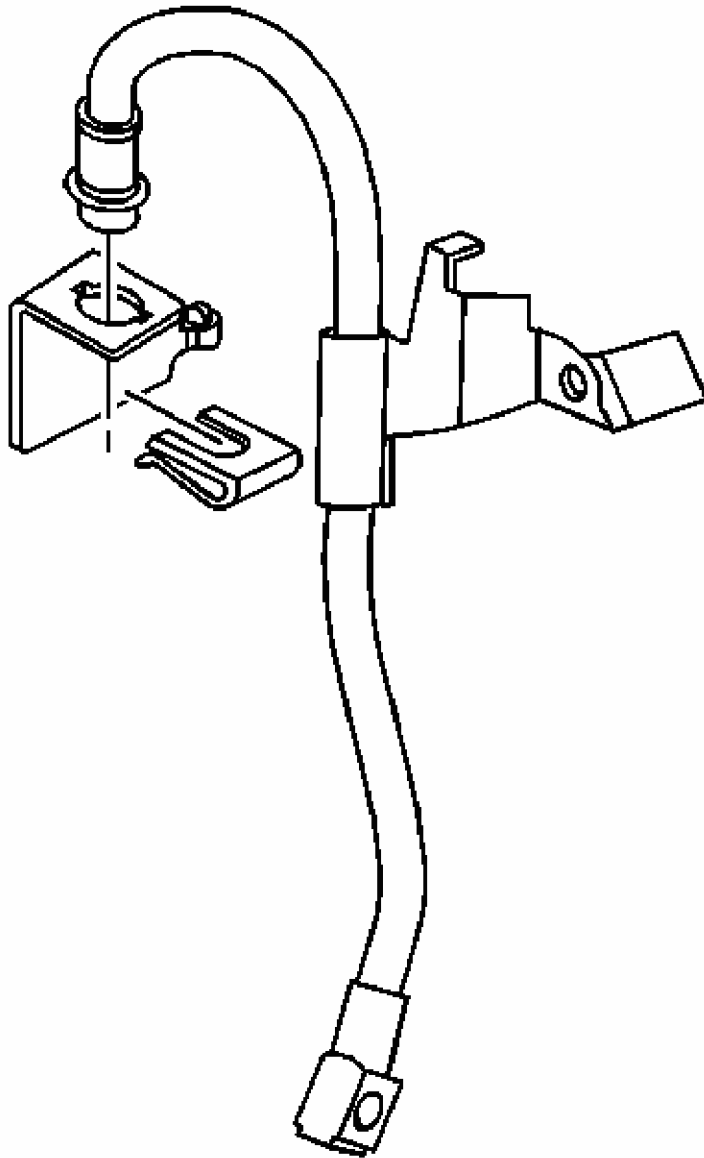


Fig. 30: Removing/Installing Brake Hose
Courtesy of GENERAL MOTORS CORP.

5. Use a flat-bladed tool in order to remove the brake hose retainer from the brake hose.
6. Remove the brake hose from the brake hose bracket.

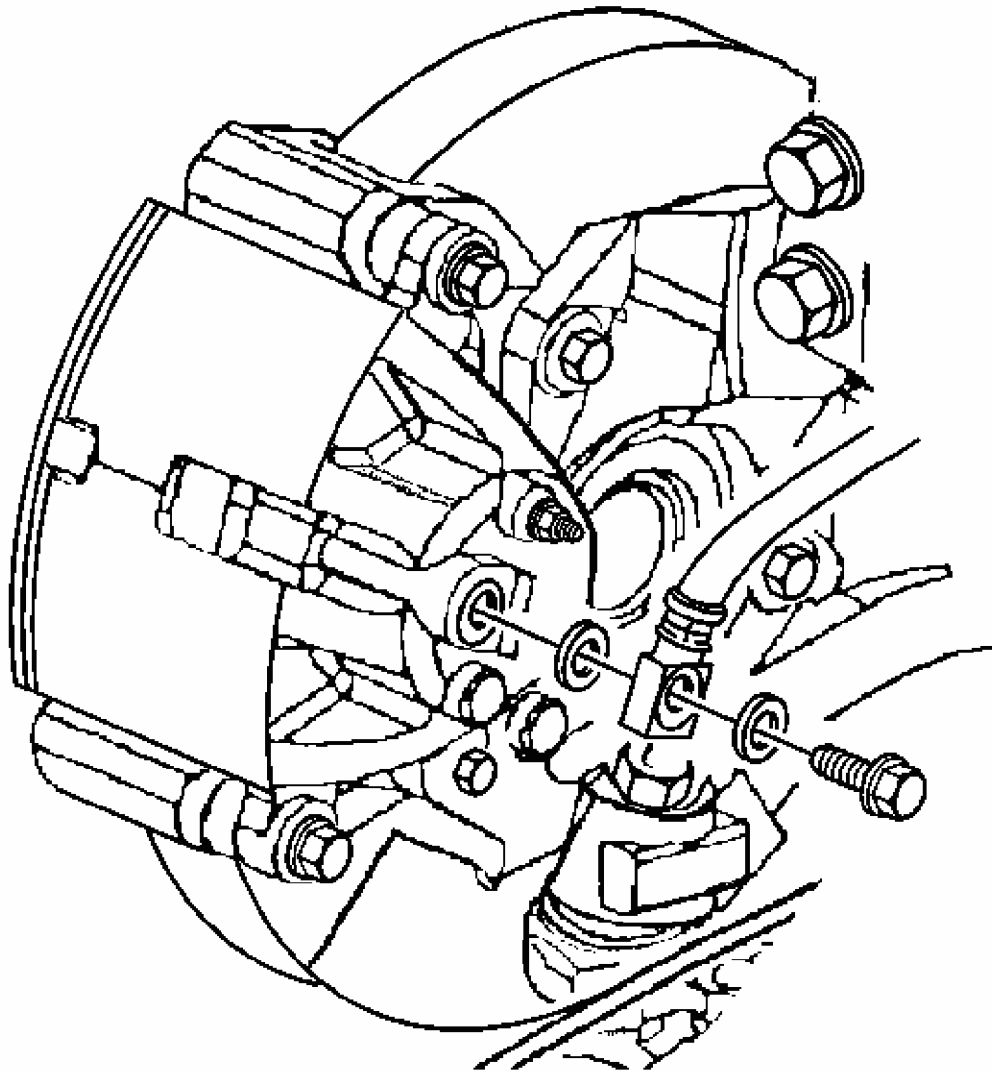


Fig. 31: Brake Hose To Caliper View
Courtesy of GENERAL MOTORS CORP.

7. Remove the brake hose bolt from the brake caliper.
8. Remove the brake hose from the brake caliper.
9. Remove and discard the two copper brake hose gaskets. These gaskets may be stuck to the brake caliper and/or the brake hose end.
10. Install a rubber plug into the brake hose bolt hole of the brake caliper in order to prevent brake fluid loss and contamination.

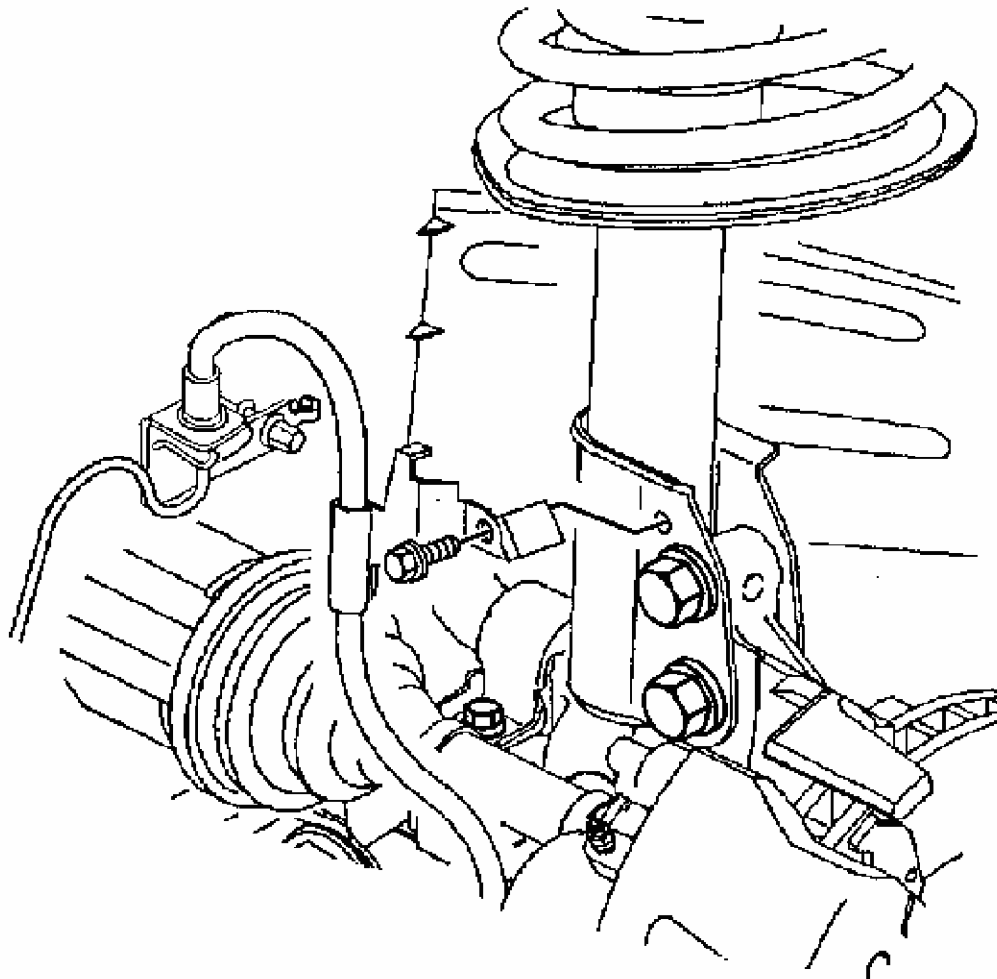


Fig. 32: Locating Brake Hose Retainer Bolt
Courtesy of GENERAL MOTORS CORP.

11. Remove the hose bracket bolt from the strut assembly and remove the hose.

Installation Procedure

1. Remove the rubber plug from the brake hose bolt hole of the brake caliper.

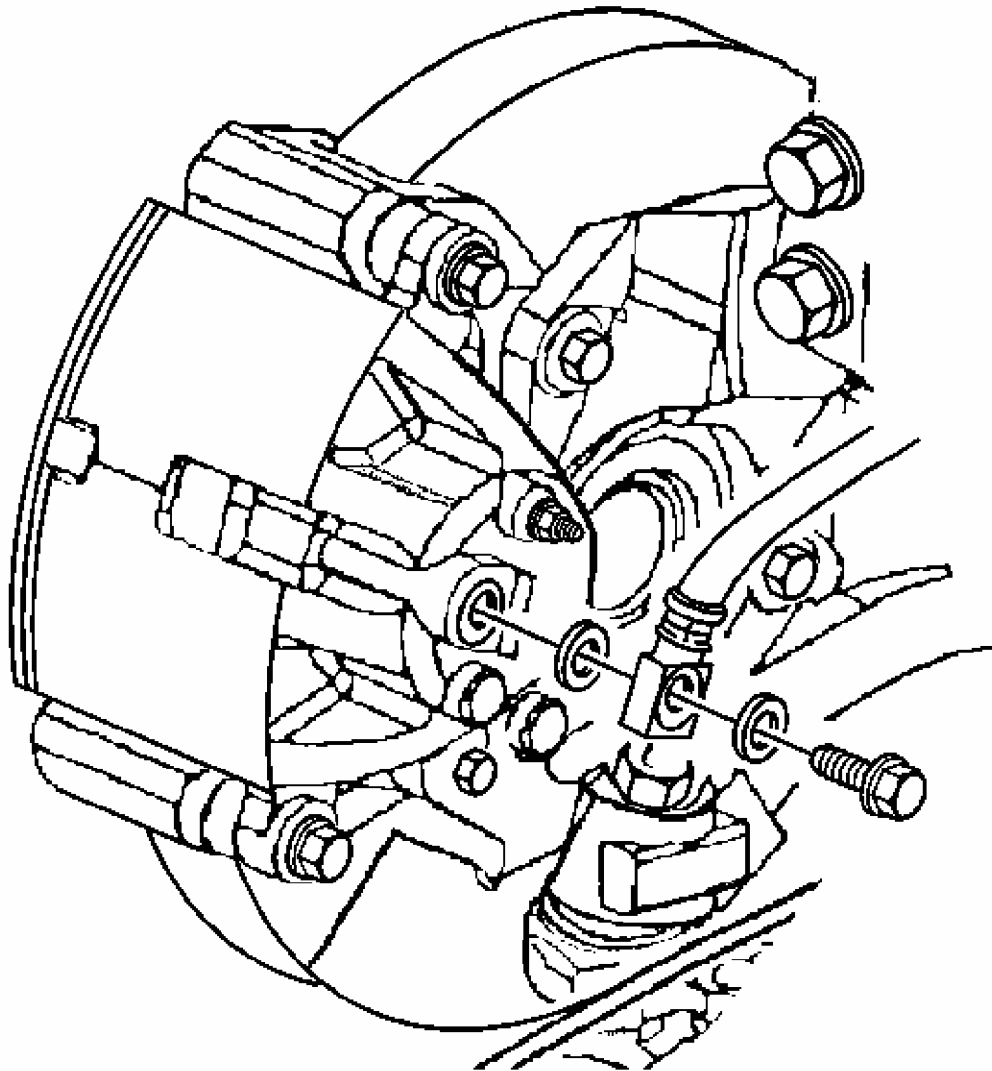


Fig. 33: Brake Hose To Caliper View
Courtesy of GENERAL MOTORS CORP.

IMPORTANT: Install NEW copper brake hose gaskets.

2. Assemble the brake hose bolt and the NEW copper brake hose gaskets to the brake hose.

NOTE: Refer to FASTENER NOTICE in Cautions and Notices.

3. Install the brake hose bolt to the brake caliper.

Tighten: Tighten the brake hose bolt to 40 N.m (30 lb ft).

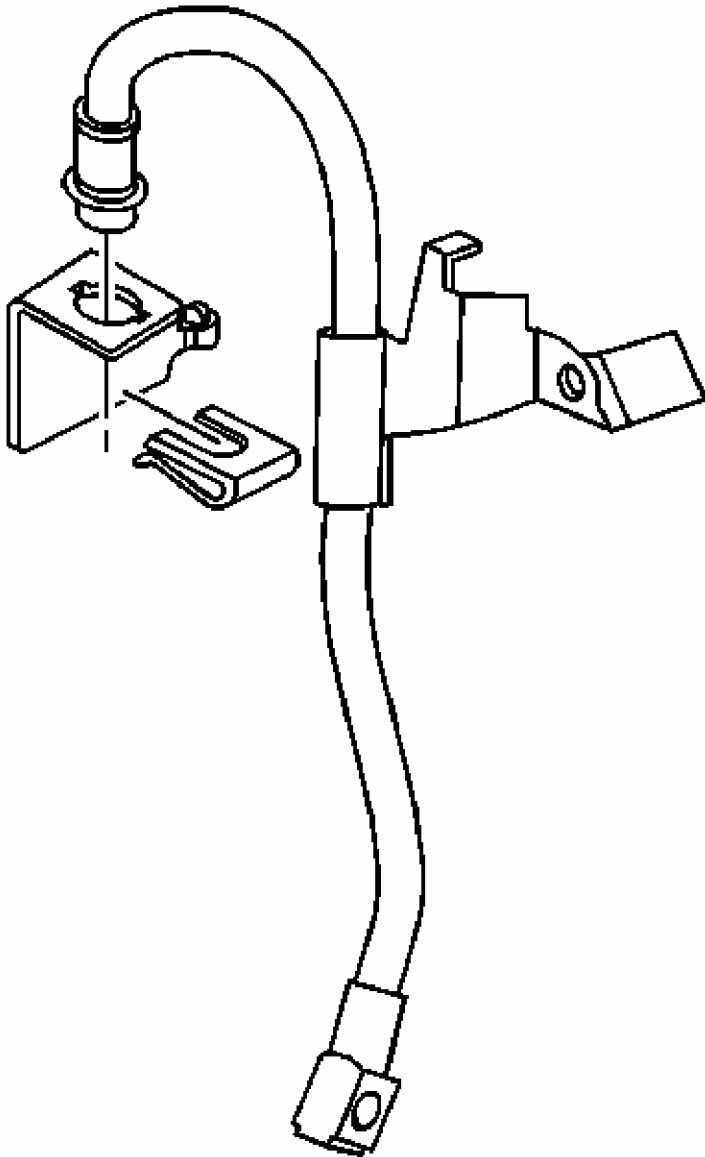


Fig. 34: Removing/Installing Brake Hose
Courtesy of GENERAL MOTORS CORP.

NOTE: Make sure the brake hose is not twisted or kinked after installation. Damage to the hose could result.

4. Install the brake hose to the brake hose bracket.

5. Install the brake hose retainer to the brake hose.

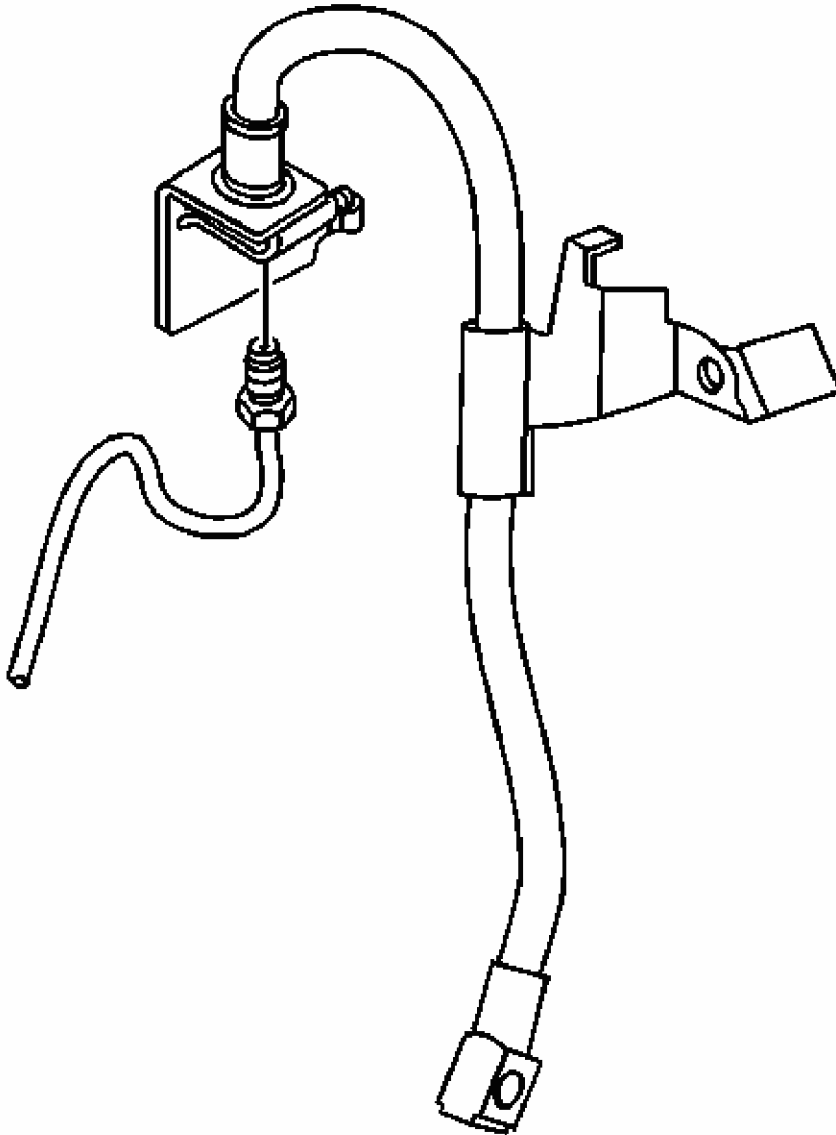


Fig. 35: Removing/Installing Brake Pipe Fitting To/From Brake Hose
Courtesy of GENERAL MOTORS CORP.

6. Remove the rubber cap or plug from the exposed brake pipe fitting end.
7. Install the brake pipe fitting to the brake hose.

Tighten: Tighten the brake pipe fitting to 15 N.m (11 lb ft).

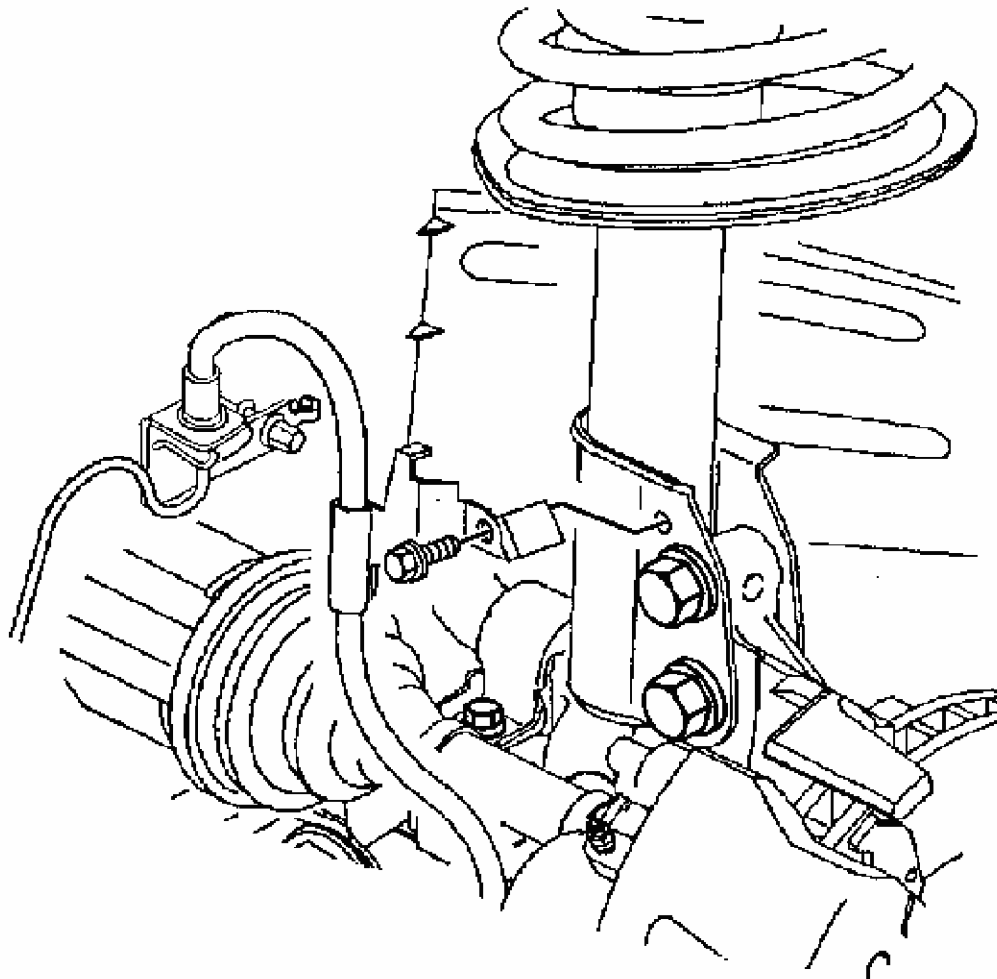


Fig. 36: Locating Brake Hose Retainer Bolt
Courtesy of GENERAL MOTORS CORP.

8. Install the hose bracket and bolt to the strut assembly.

Tighten: Tighten the bolt to 17 N.m (13 lb ft).

9. Bleed the brake caliper at the brake caliper bleeder screw. Refer to **Hydraulic Brake System Bleeding (Manual)** or **Hydraulic Brake System Bleeding (Pressure)**.
10. Install the tire and wheel assembly. Refer to **Tire and Wheel Removal and Installation** in Tires and Wheels.
11. Lower the vehicle.

REAR BRAKE HOSE REPLACEMENT

CAUTION: Refer to Brake Fluid Irritant Caution in Cautions and Notices.

NOTE: Refer to Brake Fluid Effects on Paint and Electrical Components Notice in Cautions and Notices.

Removal Procedure

1. Raise and suitably support the vehicle. Refer to Lifting and Jacking the Vehicle in General Information.
2. Remove the tire and wheel assembly. Refer to Tire and Wheel Removal and Installation in Tires and Wheels.
3. Clean all dirt and foreign material from the brake hose and the brake pipe fittings.

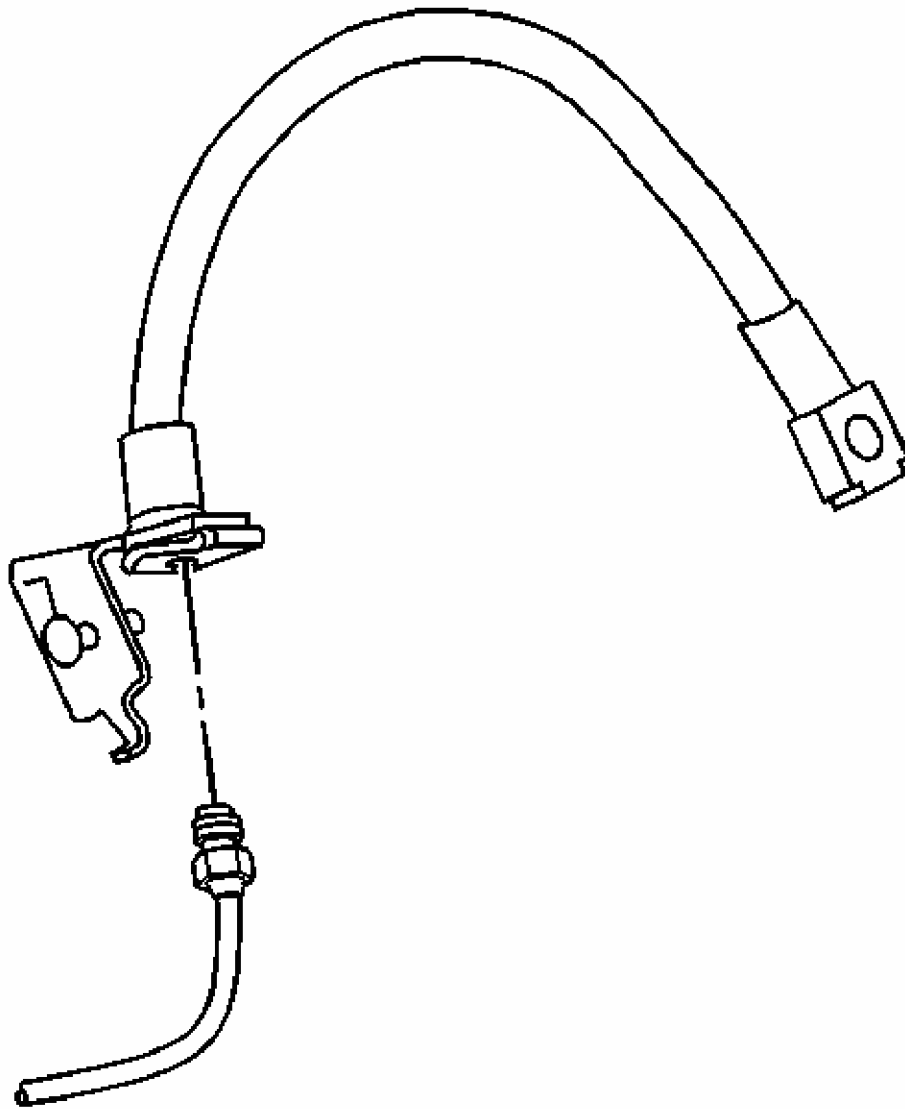


Fig. 37: Removing/Installing Rear Brake Hose
Courtesy of GENERAL MOTORS CORP.

IMPORTANT: Install a rubber cap or plug to the exposed brake pipe fitting end in order to prevent brake fluid loss and contamination.

4. Remove the brake pipe fitting from the brake hose.

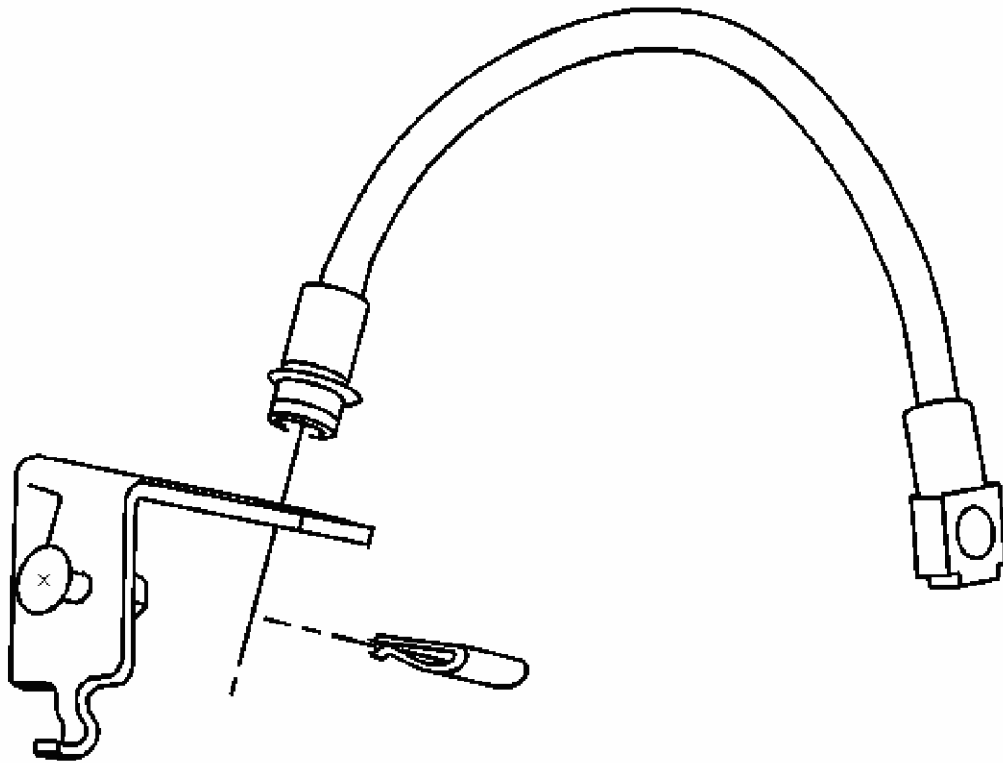


Fig. 38: Removing/Installing Brake Hose From Brake Hose Bracket
Courtesy of GENERAL MOTORS CORP.

5. Use a flat-bladed tool in order to remove the brake hose retainer from the brake hose.
6. Remove the brake hose from the brake hose bracket.

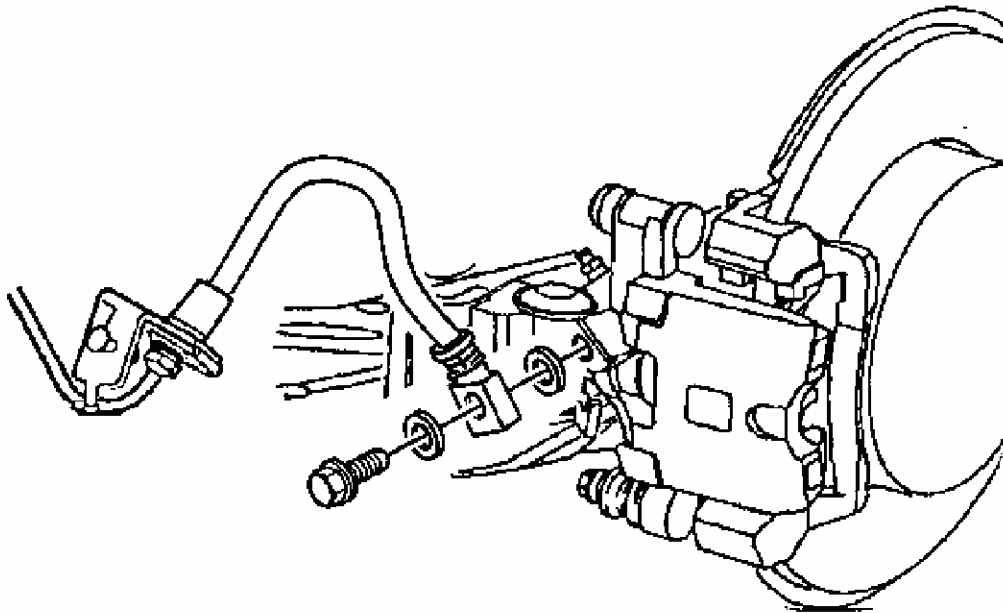


Fig. 39: Brake Hose To Caliper View
Courtesy of GENERAL MOTORS CORP.

7. Remove the brake hose bolt from the brake caliper.
8. Remove the brake hose from the brake caliper.
9. Remove and discard the two copper brake hose gaskets. These gaskets may be stuck to the brake caliper and/or the brake hose end.
10. Install a rubber plug into the brake hose bolt hole of the brake caliper in order to prevent brake fluid loss and contamination.

Installation Procedure

1. Remove the rubber plug from the brake hose bolt hole of the brake caliper.

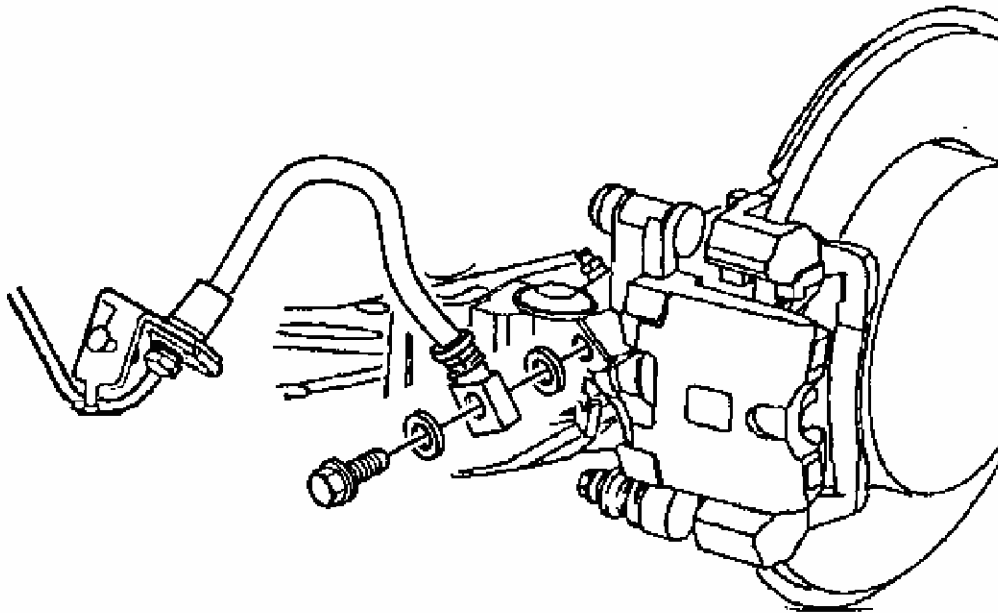


Fig. 40: Brake Hose To Caliper View
Courtesy of GENERAL MOTORS CORP.

IMPORTANT: Install NEW copper brake hose gaskets.

2. Assemble the brake hose bolt and the NEW copper brake hose gaskets to the brake hose.

NOTE: Refer to FASTENER NOTICE in Cautions and Notices.

3. Install the brake hose bolt to the brake caliper.

Tighten: Tighten the brake hose bolt to 40 N.m (30 lb ft).

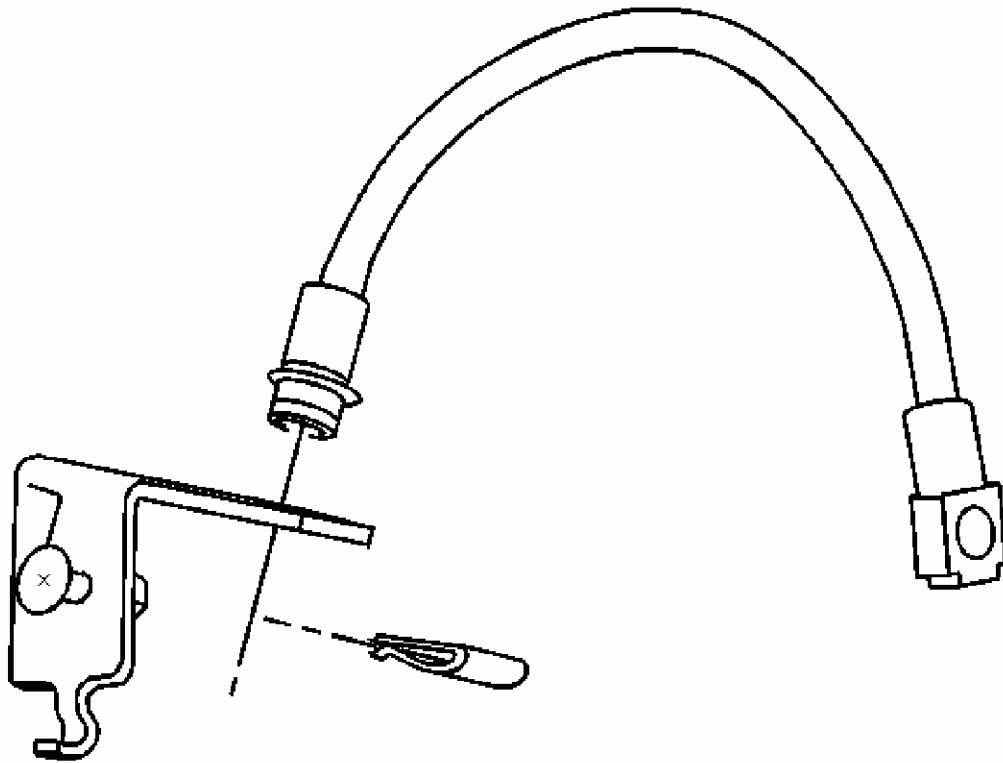


Fig. 41: Removing/Installing Brake Hose From Brake Hose Bracket
Courtesy of GENERAL MOTORS CORP.

NOTE: Make sure the brake hose is not twisted or kinked after installation. Damage to the hose could result.

4. Install the brake hose to the brake hose bracket.
5. Install the brake hose retainer to the brake hose.

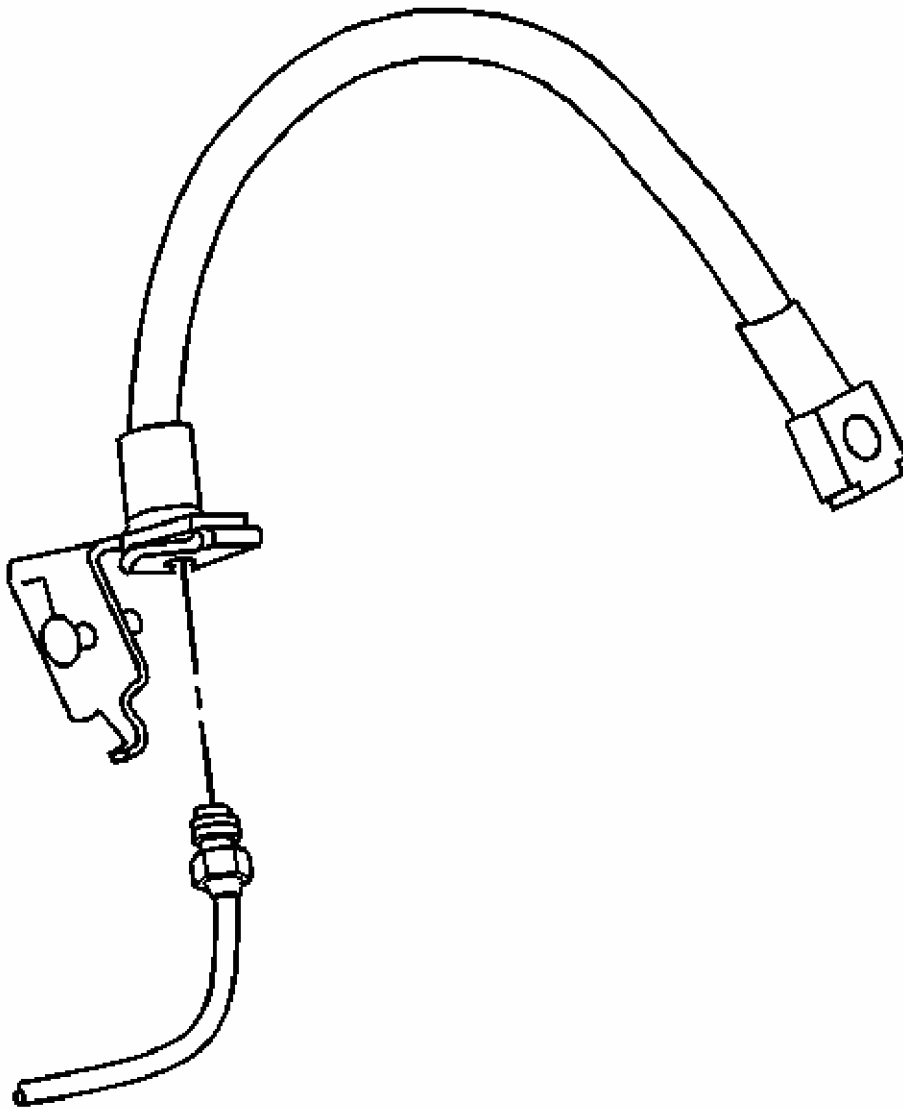


Fig. 42: Removing/Installing Rear Brake Hose
Courtesy of GENERAL MOTORS CORP.

6. Remove the rubber cap or plug from the exposed brake pipe fitting end.
7. Install the brake pipe fitting to the brake hose.

Tighten: Tighten the brake pipe fitting to 15 N.m (11 lb ft).

CAUTION: Do not move the vehicle until a firm brake pedal is obtained. Air in the brake system can cause the loss of

brakes with possible personal injury.

8. Bleed the brake caliper at the brake caliper bleeder screw. Refer to **Hydraulic Brake System Bleeding (Manual)** or **Hydraulic Brake System Bleeding (Pressure)**.
9. Install the tire and wheel assembly. Refer to **Tire and Wheel Removal and Installation** in Tires and Wheels.
10. Lower the vehicle.

HYDRAULIC BRAKE SYSTEM BLEEDING (MANUAL)

CAUTION: Refer to **Brake Fluid Irritant Caution** .

NOTE: When adding fluid to the brake master cylinder reservoir, use only Delco Supreme 11®, GM P/N 12377967 (Canadian P/N 992667) or equivalent DOT-3 brake fluid from a clean, sealed brake fluid container. The use of any type of fluid other than the recommended type of brake fluid, may cause contamination which could result in damage to the internal rubber seals and/or rubber linings of hydraulic brake system components.

NOTE: Refer to **Brake Fluid Effects on Paint and Electrical Components Notice** .

1. Place a clean shop cloth beneath the brake master cylinder to prevent brake fluid spills.
2. With the ignition OFF and the brakes cool, apply the brakes 3-5 times or until the brake pedal effort increases significantly, in order to deplete the brake booster power reserve.
3. If you have performed a brake master cylinder bench bleeding on this vehicle or if you disconnected the brake pipes from the master cylinder, you must perform the following steps:
 1. Ensure that the brake master cylinder reservoir is full to the maximum-fill level. If necessary, add Delco Supreme 11®, GM P/N 12377967 (Canadian P/N 992667) or equivalent DOT-3 brake fluid from a clean, sealed brake fluid container.

If removal of the reservoir cap and diaphragm is necessary, clean the outside of the reservoir on and around the cap prior to removal.

2. With the rear brake pipe installed securely to the master cylinder, loosen and separate the front brake pipe from the front port of the brake master cylinder.
3. Allow a small amount of brake fluid to gravity bleed from the open port of the master cylinder.

4. Reconnect the brake pipe to the master cylinder port and tighten securely.
 5. Have an assistant slowly depress the brake pedal fully and maintain steady pressure on the pedal.
 6. Loosen the same brake pipe to purge air from the open port of the master cylinder.
 7. Tighten the brake pipe, then have the assistant slowly release the brake pedal.
 8. Wait 15 seconds, then repeat steps 3.3-3.7 until all air is purged from the same port of the master cylinder.
 9. With the front brake pipe installed securely to the master cylinder, after all air has been purged from the front port of the master cylinder, loosen and separate the rear brake pipe from the master cylinder, then repeat steps 3.3-3.8.
 10. After completing the final master cylinder port bleeding procedure, ensure that both of the brake pipe-to-master cylinder fittings are properly tightened.
4. Fill the brake master cylinder reservoir with Delco Supreme 11®, GM P/N 12377967 (Canadian P/N 992667) or equivalent DOT-3 brake fluid from a clean, sealed brake fluid container. Ensure that the brake master cylinder reservoir remains at least half-full during this bleeding procedure. Add fluid as needed to maintain the proper level.

Clean the outside of the reservoir on and around the reservoir cap prior to removing the cap and diaphragm.

5. Install a proper box-end wrench onto the RIGHT REAR wheel hydraulic circuit bleeder valve.
6. Install a transparent hose over the end of the bleeder valve.
7. Submerge the open end of the transparent hose into a transparent container partially filled with Delco Supreme 11®, GM P/N 12377967 (Canadian P/N 992667) or equivalent DOT-3 brake fluid from a clean, sealed brake fluid container.
8. Have an assistant slowly depress the brake pedal fully and maintain steady pressure on the pedal.
9. Loosen the bleeder valve to purge air from the wheel hydraulic circuit.
10. Tighten the bleeder valve, then have the assistant slowly release the brake pedal.
11. Wait 15 seconds, then repeat steps 8-10 until all air is purged from the same wheel hydraulic circuit.
12. With the right rear wheel hydraulic circuit bleeder valve tightened securely, after all air has been purged from the right rear hydraulic circuit, install a proper box-end wrench onto the LEFT FRONT wheel hydraulic circuit bleeder valve.
13. Install a transparent hose over the end of the bleeder valve, then repeat steps 7-11.
14. With the left front wheel hydraulic circuit bleeder valve tightened securely, after all air has been purged from the left front hydraulic circuit, install a proper box-end wrench onto the LEFT REAR wheel hydraulic circuit bleeder valve.

15. Install a transparent hose over the end of the bleeder valve, then repeat steps 7-11.
16. With the left rear wheel hydraulic circuit bleeder valve tightened securely, after all air has been purged from the left rear hydraulic circuit, install a proper box-end wrench onto the RIGHT FRONT wheel hydraulic circuit bleeder valve.
17. Install a transparent hose over the end of the bleeder valve, then repeat steps 7-11.
18. After completing the final wheel hydraulic circuit bleeding procedure, ensure that each of the 4 wheel hydraulic circuit bleeder valves are properly tightened.
19. Fill the brake master cylinder reservoir to the maximum-fill level with Delco Supreme 11®, GM P/N 12377967 (Canadian P/N 992667) or equivalent DOT-3 brake fluid from a clean, sealed brake fluid container.
20. Slowly depress and release the brake pedal. Observe the feel of the brake pedal.

IMPORTANT: If it is determined that air was induced into the system upstream of the ABS modulator prior to servicing, the Antilock Brake System Automated Bleed Procedure must be performed.

21. If the brake pedal feels spongy, repeat the bleeding procedure again. If the brake pedal still feels spongy after repeating the bleeding procedure, perform the following steps:
 1. Inspect the brake system for external leaks. Refer to **Brake System External Leak Inspection**.
 2. Pressure bleed the hydraulic brake system in order to purge any air that may still be trapped in the system.
22. Turn the ignition key ON, with the engine OFF. Check to see if the brake system warning lamp remains illuminated.

IMPORTANT: DO NOT allow the vehicle to be driven until it is diagnosed and repaired.

23. If the brake system warning lamp remains illuminated, refer to **Symptoms - Hydraulic Brakes**.

HYDRAULIC BRAKE SYSTEM BLEEDING (PRESSURE)

Tools Required

- **J 29532** Diaphragm Type Brake Pressure Bleeder or equivalent. See **Special Tools**.
- **J 35589-A** Master Cylinder Bleeder Adapter. See **Special Tools**.

CAUTION: Refer to Brake Fluid Irritant Caution.

NOTE: When adding fluid to the brake master cylinder reservoir, use only Delco Supreme 11®, GM P/N 12377967 (Canadian P/N 992667) or equivalent DOT-3 brake fluid from a clean, sealed brake fluid container. The use of any type of fluid other than the recommended type of brake fluid, may cause contamination which could result in damage to the internal rubber seals and/or rubber linings of hydraulic brake system components.

NOTE: Refer to Brake Fluid Effects on Paint and Electrical Components Notice .

Bleeding Procedure

1. Place a clean shop cloth beneath the brake master cylinder to prevent brake fluid spills.
2. With the ignition OFF and the brakes cool, apply the brakes 3-5 times or until the brake pedal effort increases significantly, in order to deplete the brake booster power reserve.
3. If you have performed a brake master cylinder bench bleeding on this vehicle or if you disconnected the brake pipes from the master cylinder, you must perform the following steps:
 1. Ensure that the brake master cylinder reservoir is full to the maximum-fill level. If necessary, add Delco Supreme 11®, GM P/N 12377967 (Canadian P/N 992667) or equivalent DOT-3 brake fluid from a clean, sealed brake fluid container.

If removal of the reservoir cap and diaphragm is necessary, clean the outside of the reservoir on and around the cap prior to removal.

2. With the rear brake pipe installed securely to the master cylinder, loosen and separate the front brake pipe from the front port of the brake master cylinder.
3. Allow a small amount of brake fluid to gravity bleed from the open port of the master cylinder.
4. Reconnect the brake pipe to the master cylinder port and tighten securely.
5. Have an assistant slowly depress the brake pedal fully and maintain steady pressure on the pedal.
6. Loosen the same brake pipe to purge air from the open port of the master cylinder.
7. Tighten the brake pipe, then have the assistant slowly release the brake pedal.
8. Wait 15 seconds, then repeat steps 3.3-3.7 until all air is purged from the same port of the master cylinder.
9. With the front brake pipe installed securely to the master cylinder, after all air has been purged from the front port of the master cylinder, loosen and separate the rear brake pipe from the master cylinder, then repeat steps 3.3-3.8.
10. After completing the final master cylinder port bleeding procedure, ensure that both

of the brake pipe-to-master cylinder fittings are properly tightened.

4. Fill the brake master cylinder reservoir to the maximum-fill level with Delco Supreme 11®, GM P/N 12377967 (Canadian P/N 992667) or equivalent DOT-3 brake fluid from a clean, sealed brake fluid container.

Clean the outside of the reservoir on and around the reservoir cap prior to removing the cap and diaphragm.

5. Install the **J 35589-A** to the brake master cylinder reservoir. See **Special Tools**.
6. Check the brake fluid level in the **J 29532** or equivalent. See **Special Tools**. Add Delco Supreme 11®, GM P/N 12377967 (Canadian P/N 992667) or equivalent DOT-3 brake fluid from a clean, sealed brake fluid container as necessary to bring the level to approximately the half-full point.
7. Connect the **J 29532** or equivalent, to the **J 35589-A**. See **Special Tools**.
8. Charge the **J 29532** or equivalent, air tank to 175-205 kPa (25-30 psi). See **Special Tools**.
9. Open the **J 29532** or equivalent, fluid tank valve to allow pressurized brake fluid to enter the brake system. See **Special Tools**.
10. Wait approximately 30 seconds, then inspect the entire hydraulic brake system in order to ensure that there are no existing external brake fluid leaks.

Any brake fluid leaks identified require repair prior to completing this procedure.

11. Install a proper box-end wrench onto the RIGHT REAR wheel hydraulic circuit bleeder valve.
12. Install a transparent hose over the end of the bleeder valve.
13. Submerge the open end of the transparent hose into a transparent container partially filled with Delco Supreme 11®, GM P/N 12377967 (Canadian P/N 992667) or equivalent DOT-3 brake fluid from a clean, sealed brake fluid container.
14. Loosen the bleeder valve to purge air from the wheel hydraulic circuit. Allow fluid to flow until air bubbles stop flowing from the bleeder, then tighten the bleeder valve.
15. With the right rear wheel hydraulic circuit bleeder valve tightened securely, after all air has been purged from the right rear hydraulic circuit, install a proper box-end wrench onto the LEFT FRONT wheel hydraulic circuit bleeder valve.
16. Install a transparent hose over the end of the bleeder valve, then repeat steps 13-14.
17. With the left front wheel hydraulic circuit bleeder valve tightened securely, after all air has been purged from the left front hydraulic circuit, install a proper box-end wrench onto the LEFT REAR wheel hydraulic circuit bleeder valve.
18. Install a transparent hose over the end of the bleeder valve, then repeat steps 13-14.
19. With the left rear wheel hydraulic circuit bleeder valve tightened securely, after all air

has been purged from the left rear hydraulic circuit, install a proper box-end wrench onto the RIGHT FRONT wheel hydraulic circuit bleeder valve

20. Install a transparent hose over the end of the bleeder valve, then repeat steps 13-14.
21. After completing the final wheel hydraulic circuit bleeding procedure, ensure that each of the 4 wheel hydraulic circuit bleeder valves are properly tightened.
22. Close the **J 29532** or equivalent, fluid tank valve, then disconnect the **J 29532** or equivalent, from the **J 35589-A** . See **Special Tools**.
23. Remove the **J 35589-A** from the brake master cylinder reservoir. See **Special Tools**.
24. Fill the brake master cylinder reservoir to the maximum-fill level with Delco Supreme 11®, GM P/N 12377967 (Canadian P/N 992667) or equivalent DOT-3 brake fluid from a clean, sealed brake fluid container.
25. Slowly depress and release the brake pedal. Observe the feel of the brake pedal.

IMPORTANT: If it is determined that air was induced into the system upstream of the ABS modulator prior to servicing, the Antilock Brake System Automated Bleed Procedure must be performed.

26. If the brake pedal feels spongy, perform the following steps:
 1. Inspect the brake system for external leaks. Refer to **Brake System External Leak Inspection** .
 2. Using a scan tool, perform the antilock brake system automated bleeding procedure to remove any air that may have been trapped in the brake pressure modulator valve (BPMV). Refer to **Antilock Brake System Automated Bleed Procedure** .
27. Turn the ignition key ON, with the engine OFF. Check to see if the brake system warning lamp remains illuminated.

IMPORTANT: DO NOT allow the vehicle to be driven until it is diagnosed and repaired.

28. If the brake system warning lamp remains illuminated, refer to **Symptoms - Hydraulic Brakes**.

HYDRAULIC BRAKE SYSTEM FLUSHING

CAUTION: Refer to Brake Fluid Irritant Caution .

NOTE: When adding fluid to the brake master cylinder reservoir, use only Delco Supreme 11®, GM P/N 12377967 (Canadian P/N

992667) or equivalent DOT-3 brake fluid from a clean, sealed brake fluid container. The use of any type of fluid other than the recommended type of brake fluid, may cause contamination which could result in damage to the internal rubber seals and/or rubber linings of hydraulic brake system components.

NOTE: Refer to Brake Fluid Effects on Paint and Electrical Components Notice .

1. Inspect the brake fluid for the following conditions, indicating brake fluid contamination:
 - Fluid separation, indicating two types of fluid are present; a substance other than the recommended brake fluid has been introduced into the brake hydraulic system
 - Swirled appearance-Oil-based substance
 - Layered appearance-Silicone-based substance
 - Fluid discoloration, indicating the presence of moisture or particles that have been introduced into the brake hydraulic system
 - Cloudy appearance-Moisture
 - Dark appearance/suspended particles in fluid-Dirt, rust, corrosion, brake dust
2. Inspect the master cylinder reservoir cap diaphragm and the reservoir-to-master cylinder grommets for swelling, indicating brake fluid contamination.
3. If the brake fluid WAS contaminated with an oil-based or a silicone-based substance, indicated by fluid separation and/or a swollen master cylinder reservoir cap diaphragm and/or swollen reservoir-to-master cylinder grommets, perform the following:
 1. Remove ALL of the following components listed from the vehicle. Each component contains internal rubber seals/linings which have been contaminated by the contaminated brake fluid in the brake hydraulic system.

Refer to the procedures indicated:

- **Master Cylinder Replacement**
 - **Front Brake Hose Replacement**
 - **Rear Brake Hose Replacement**
 - **Front Brake Caliper Replacement**
 - **Rear Brake Caliper Replacement**
 - **Brake Pressure Modulator Valve Replacement**
2. Clean out all the hydraulic brake pipes using denatured alcohol or equivalent.
 3. Dry the brake pipes using non-lubricated, filtered air.
 4. Repair or replace ALL of the following components listed and install them to the

vehicle. Each component contains internal rubber seals/linings which have been contaminated by the contaminated brake fluid in the brake hydraulic system.

Refer to the procedures indicated:

- **Master Cylinder Replacement** ; also perform the following:

Clean the brake master cylinder reservoir using denatured alcohol or equivalent, then dry the reservoir using non-lubricated, filtered air. Inspect the reservoir for cracks and/or damage and replace if necessary. Refer to **Master Cylinder Reservoir Replacement** .

Replace the brake master cylinder reservoir cap diaphragm.

- **Front Brake Hose Replacement**
- **Rear Brake Hose Replacement**
- **Front Brake Caliper Overhaul** or **Front Brake Caliper Replacement**
- **Rear Brake Caliper Replacement**
- **Brake Pressure Modulator Valve Replacement**

4. If the brake fluid was NOT contaminated with an oil-based or a silicone-based substance, but WAS contaminated with water or dirt, rust, corrosion, and/or brake dust, replace the brake master cylinder reservoir cap diaphragm. The diaphragm may have allowed the moisture or particles to enter the hydraulic system.
5. Fill the brake master cylinder reservoir to the maximum-fill level with Delco Supreme 11®, GM P/N 12377967, Canadian P/N 992667 or equivalent DOT-3 brake fluid from a clean, sealed brake fluid container.
6. Pressure bleed the hydraulic brake system. Begin the procedure with the pressure bleeder reservoir filled to the maximum-fill level with the correct brake fluid as indicated. Refer to **Hydraulic Brake System Bleeding (Manual)** or **Hydraulic Brake System Bleeding (Pressure)**.

POWER VACUUM BRAKE BOOSTER REPLACEMENT (4.6L V-8)

Removal Procedure

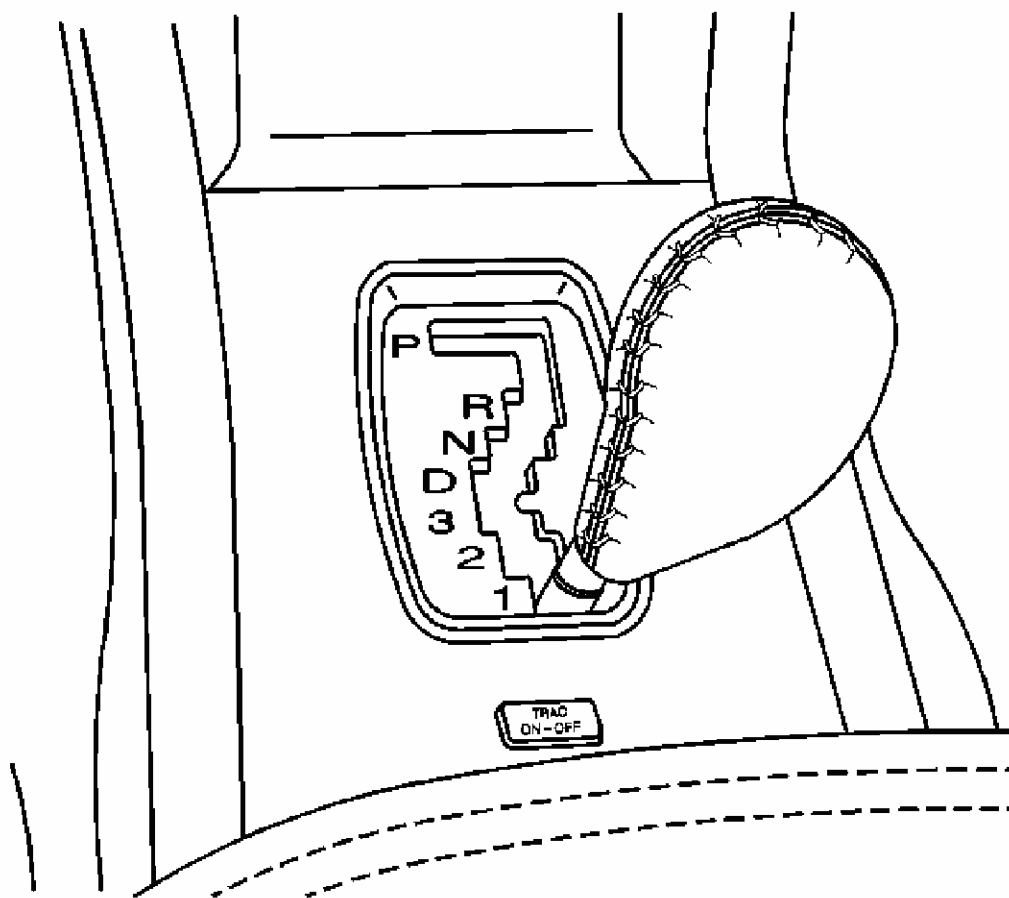


Fig. 43: Positioning Gearshift Lever
Courtesy of GENERAL MOTORS CORP.

1. Place the vehicle on a flat surface.
2. Block the front wheels.
3. Apply the parking brake.
4. To allow access for the removal of the vacuum brake booster, position the gearshift lever into the lowest gear.
5. Remove the air cleaner assembly. Refer to **Air Cleaner Assembly Replacement** .
6. Disconnect the fuel vapor lines in front of the brake booster.
 - For the lines that have the plastic connectors, refer to **Plastic Collar Quick Connect Fitting Service** .
 - For the lines that have the metal connectors, refer to **Metal Collar Quick Connect Fitting Service** .

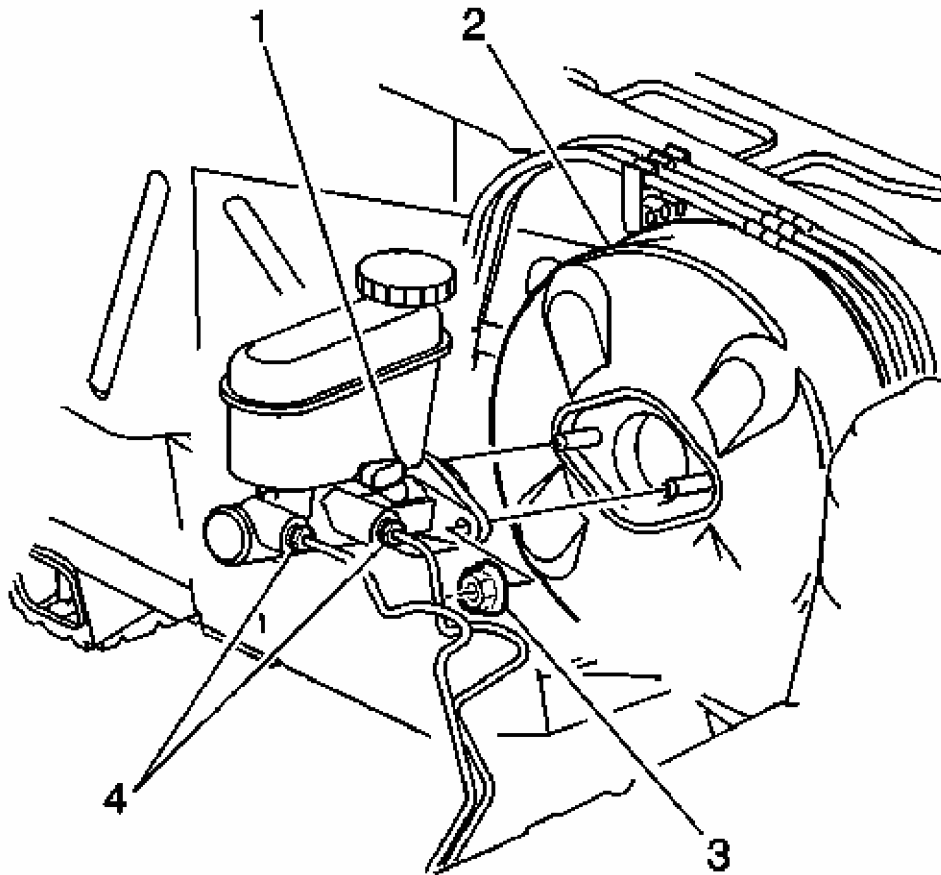


Fig. 44: Removing/Installing Master Cylinder
Courtesy of GENERAL MOTORS CORP.

7. Remove the master cylinder mounting nuts (3).

IMPORTANT: In the following service step, the master cylinder does not have to be removed. Move the master cylinder forward just enough to clear the studs on the vacuum brake booster. This will flex the brake pipes slightly. Do not bend or distort the pipes.

8. Disconnect the master cylinder (1) from the brake booster (2).
9. Disconnect the shift control cable from the shaft lever pin and position it out of the way. Refer to **Automatic Transmission Range Selector Cable Replacement - Console**.

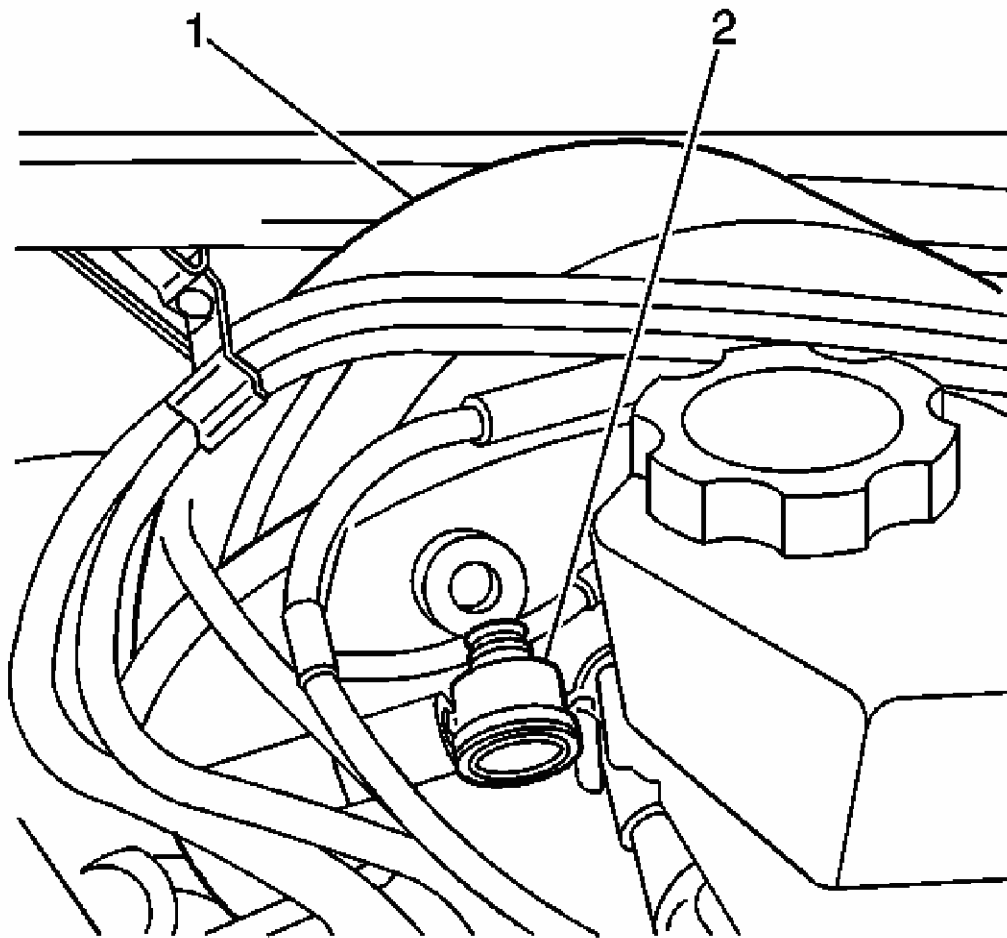


Fig. 45: View Of Vacuum Booster & Check Valve
Courtesy of GENERAL MOTORS CORP.

10. Disconnect the vacuum check valve (2) from the vacuum booster.
11. Remove the left closeout insulator panel. Refer to **Instrument Panel Insulator Panel Replacement - Left Side**.
12. Remove the left knee bolster. Refer to **Driver Knee Bolster Replacement**.
13. To access the left lower brake pedal to vacuum brake booster mounting nut, remove the steering column mounting nuts. Refer to **Steering Column Replacement**.
14. Lower the steering column and secure it.

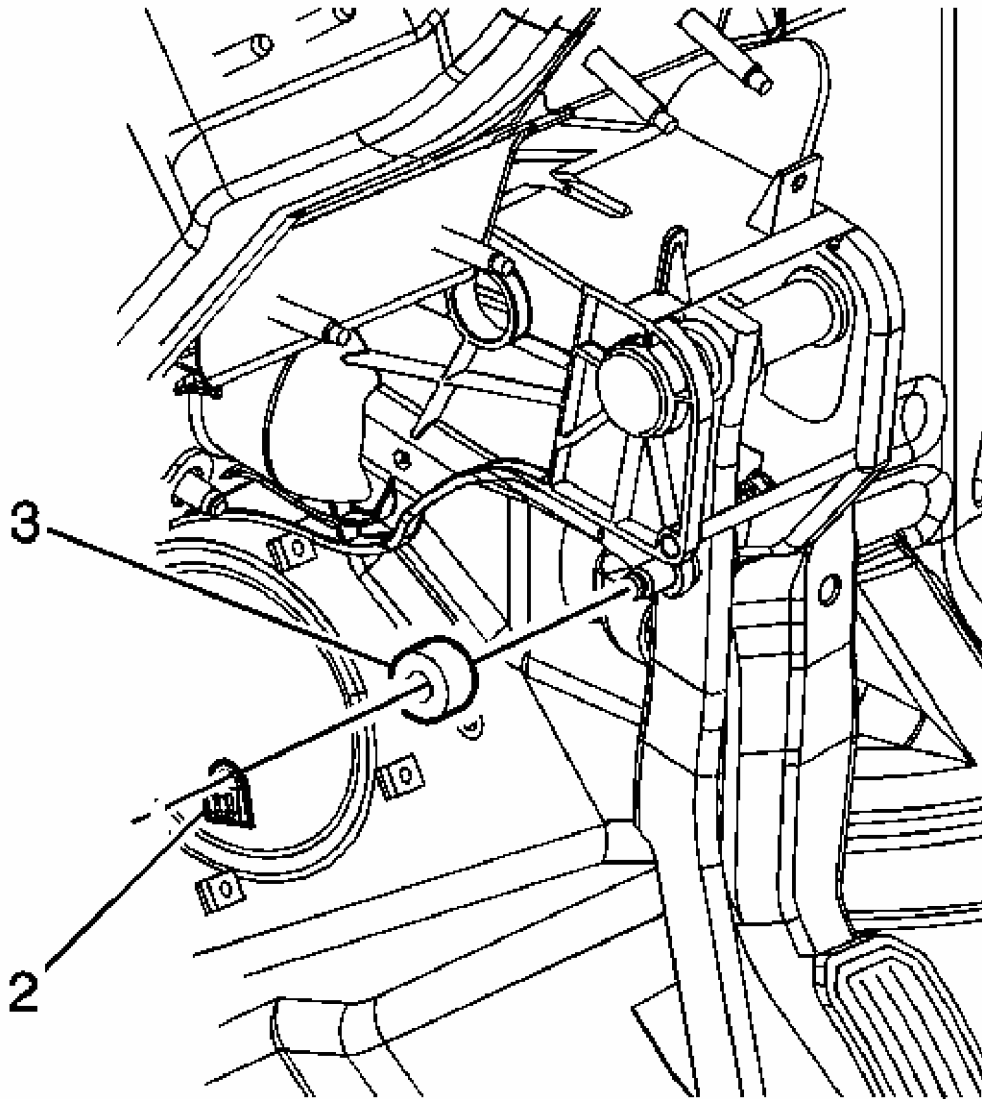


Fig. 46: Identifying Brake Pedal Assembly Clevis Pin
Courtesy of GENERAL MOTORS CORP.

15. Remove the vacuum brake booster pushrod retaining clip (2) from the brake pedal clevis pin.
16. Remove the foam spacer (3) from the brake pedal clevis pin.
17. Disconnect the brake booster pushrod from the brake pedal clevis pin.

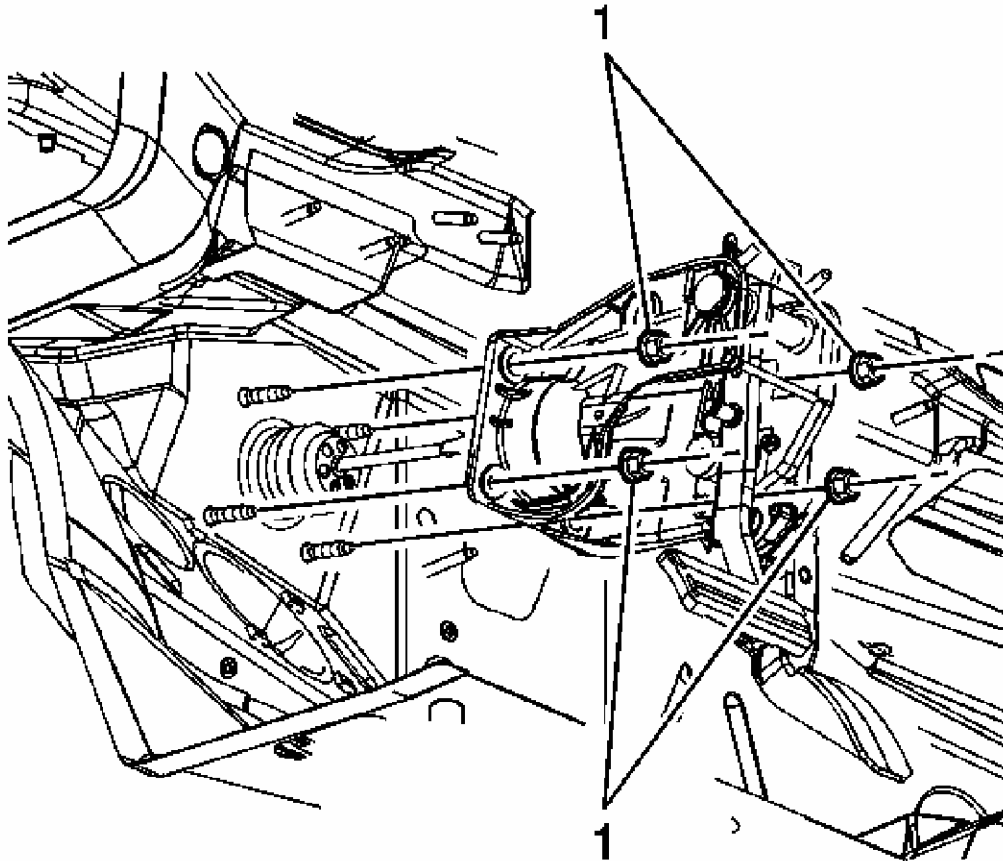


Fig. 47: Identifying Vacuum Brake Booster Mounting Nuts
Courtesy of GENERAL MOTORS CORP.

18. Remove the vacuum brake booster mounting nuts (1) from the brake pedal assembly.
19. Raise the vehicle. Refer to **Lifting and Jacking the Vehicle** .

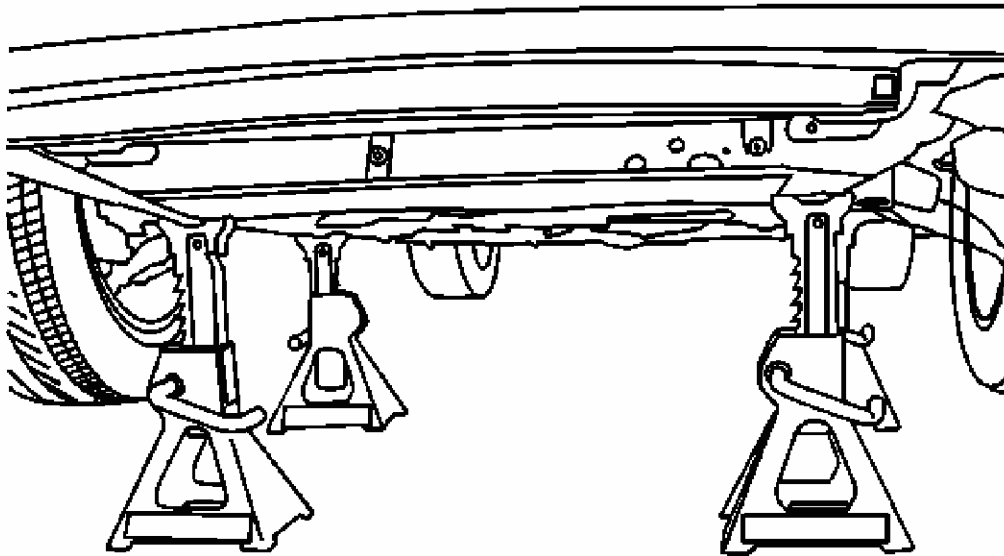


Fig. 48: Locating Jackstands Under Engine Frame
Courtesy of GENERAL MOTORS CORP.

20. Support the front frame with jack stands.
21. Loosen the left side bolts from the frame to the body. Refer to **Front Frame Replacement (3.8L)** or **Front Frame Replacement (4.6L)** .
22. Lower the left side frame 2-3 inches to gain enough clearance to remove the brake booster. Refer to **Front Frame Replacement (3.8L)** or **Front Frame Replacement (4.6L)** .

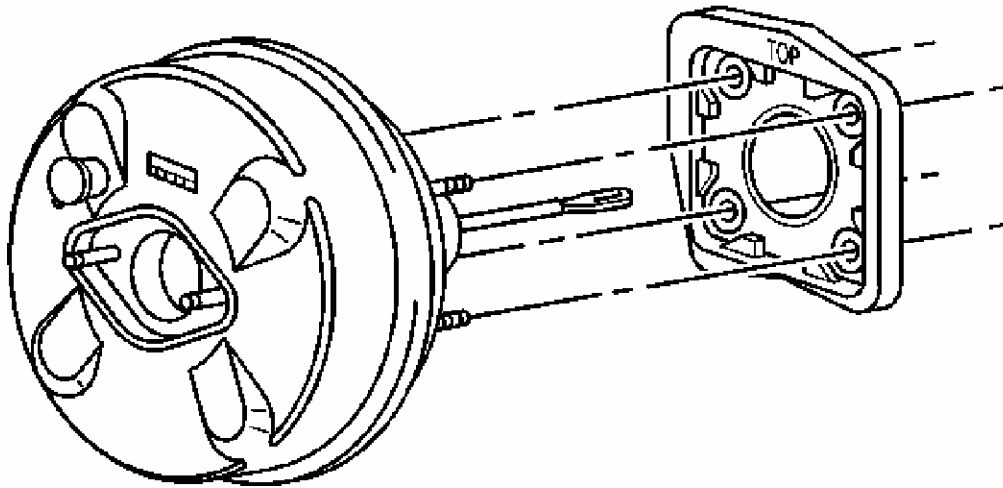


Fig. 49: View of Vacuum Brake Booster
Courtesy of GENERAL MOTORS CORP.

23. Remove the vacuum brake booster from the vehicle.

IMPORTANT: The gasket does not have to be replaced every time the booster is removed. Replace the gasket only if necessary.

24. Remove the vacuum brake booster mounting gasket.

Installation Procedure

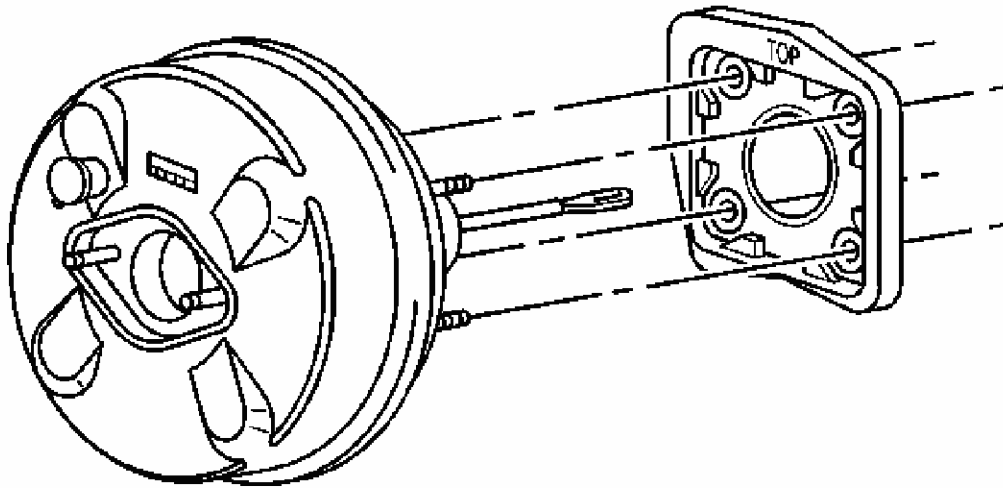


Fig. 50: View of Vacuum Brake Booster
Courtesy of GENERAL MOTORS CORP.

1. Install the vacuum brake booster mounting gasket to the booster, if removed previously.
2. Install the vacuum brake booster to the vehicle.
3. Lower the vehicle onto the engine frame. Refer to **Front Frame Replacement (3.8L)** or **Front Frame Replacement (4.6L)** .
4. Remove the jack stands.
5. Lower the vehicle.

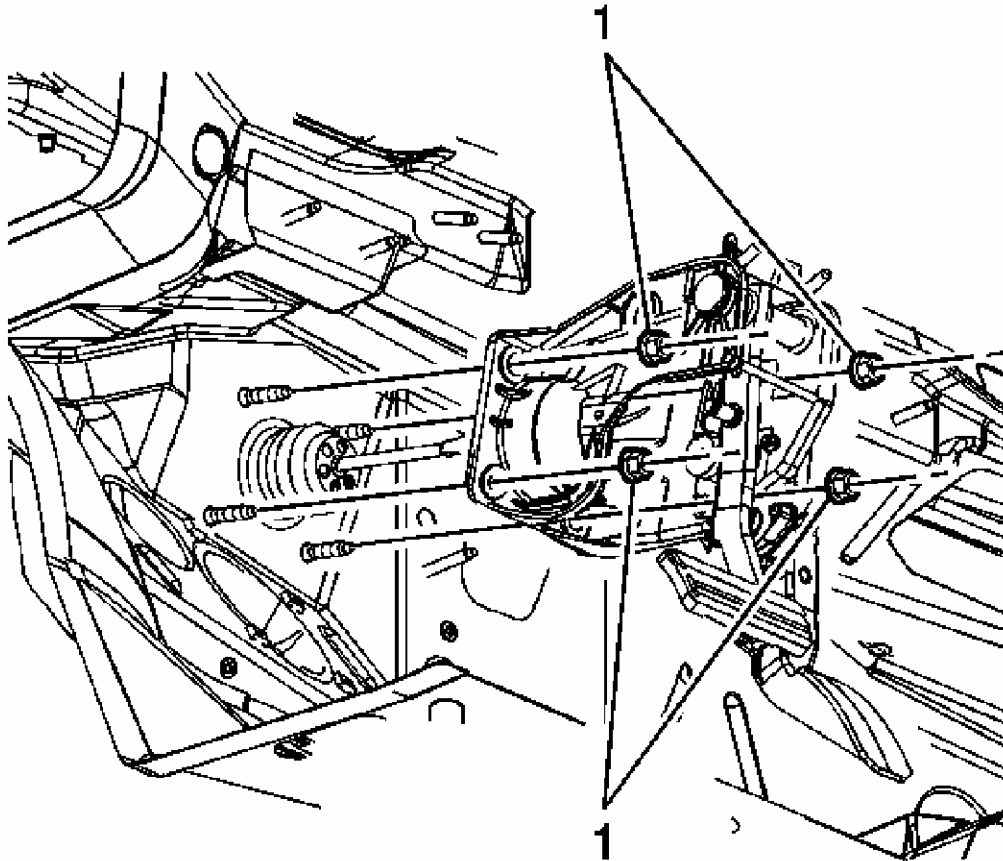


Fig. 51: Identifying Vacuum Brake Booster Mounting Nuts
Courtesy of GENERAL MOTORS CORP.

NOTE: Refer to Fastener Notice .

6. Install the brake pedal assembly to booster stud mounting nuts (1) to the booster studs.

Tighten: Tighten the brake pedal assembly to booster stud mounting nuts to 30 N.m (22 lb ft).

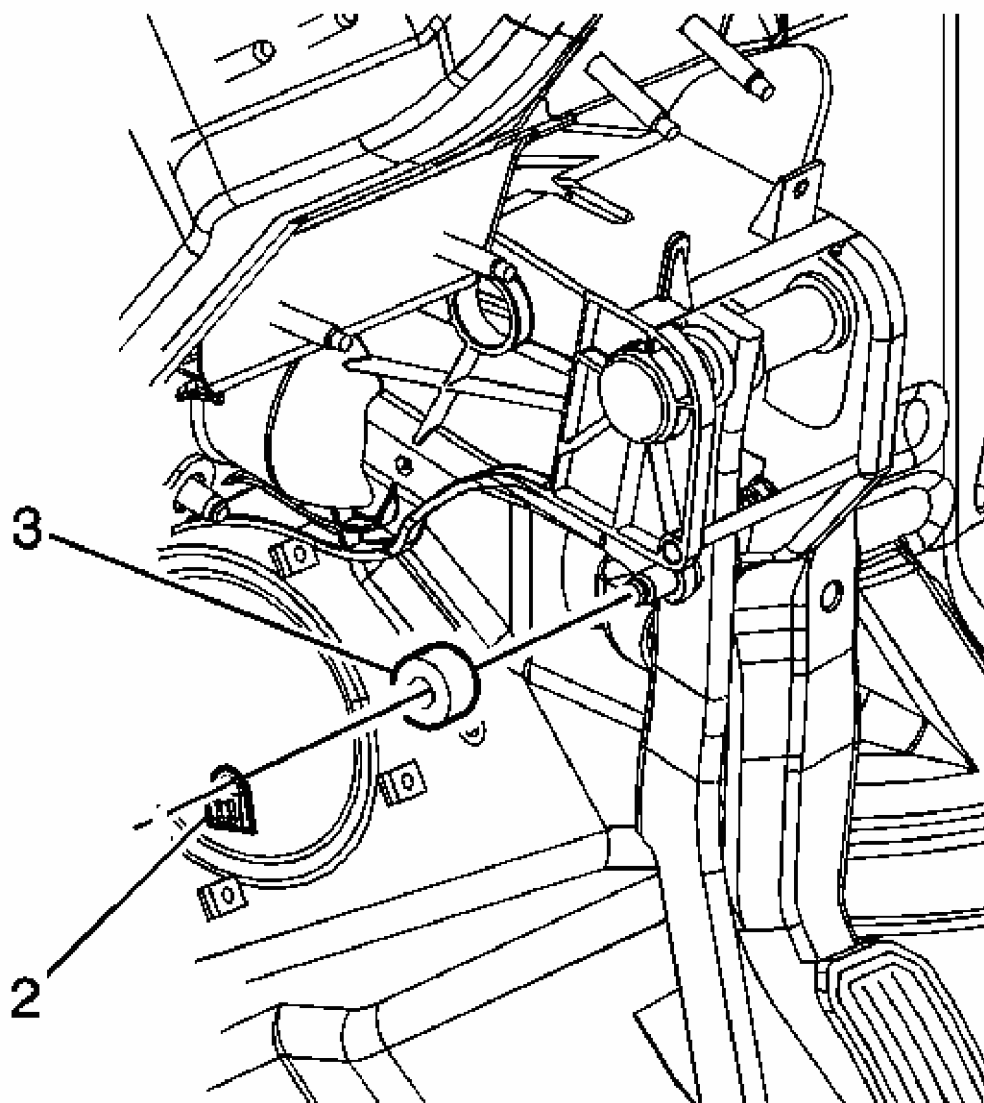


Fig. 52: Identifying Brake Pedal Assembly Clevis Pin
Courtesy of GENERAL MOTORS CORP.

7. Apply a small amount of lubricant, GM P/N 12346293 or equivalent to the clevis pin of the brake pedal.
8. Connect the vacuum brake booster pushrod to the brake pedal clevis pin.
9. Install the foam spacer (3) to the brake pedal clevis pin.
10. Install the retainer clip (2) to the brake pedal assembly clevis pin.
11. Install the steering column.

12. Install the steering column mounting attaching nuts. Refer to **Steering Column Replacement** .
13. Install the left knee bolster. Refer to **Driver Knee Bolster Replacement** .
14. Install the left closeout insulator panel. Refer to **Instrument Panel Insulator Panel Replacement - Left Side** .

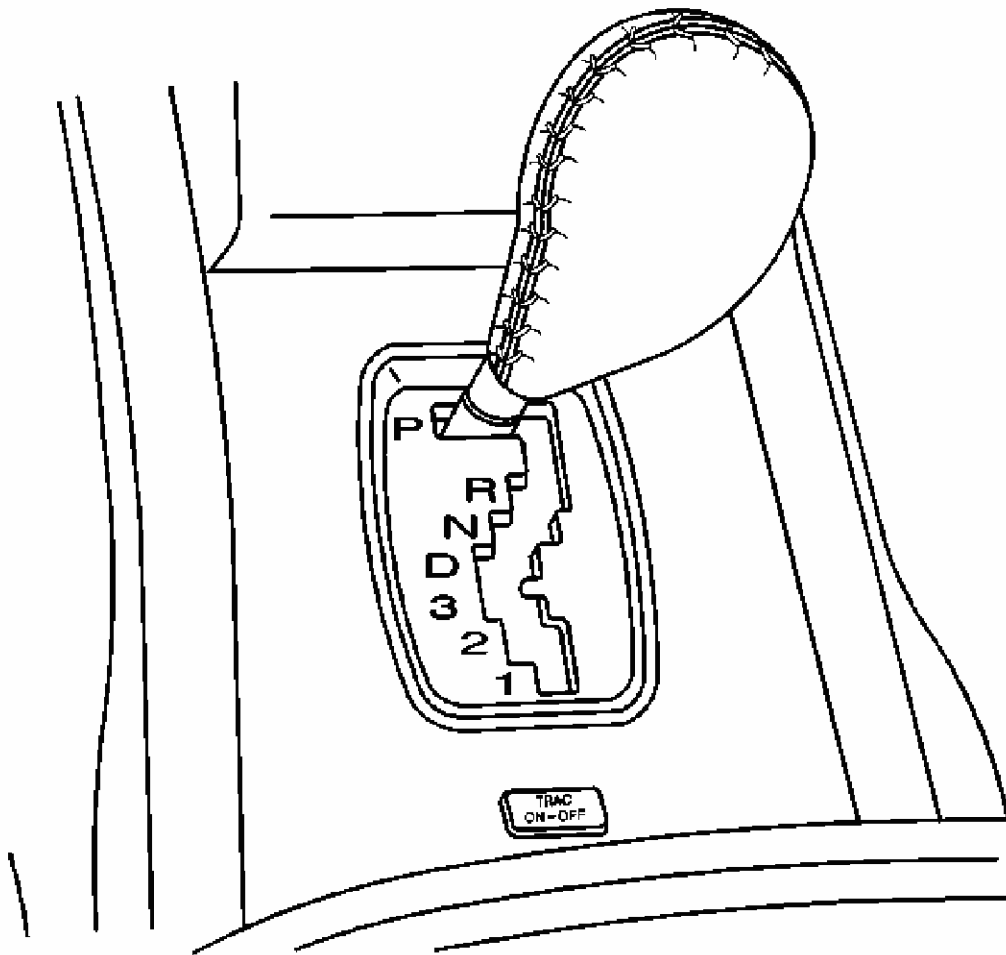


Fig. 53: Positioning Gearshift Lever Into Park
Courtesy of GENERAL MOTORS CORP.

15. Install the shift control cable to the shift cable bracket. Refer to **Automatic Transmission Range Selector Cable Replacement - Console** .
16. Position the gearshift lever into park.

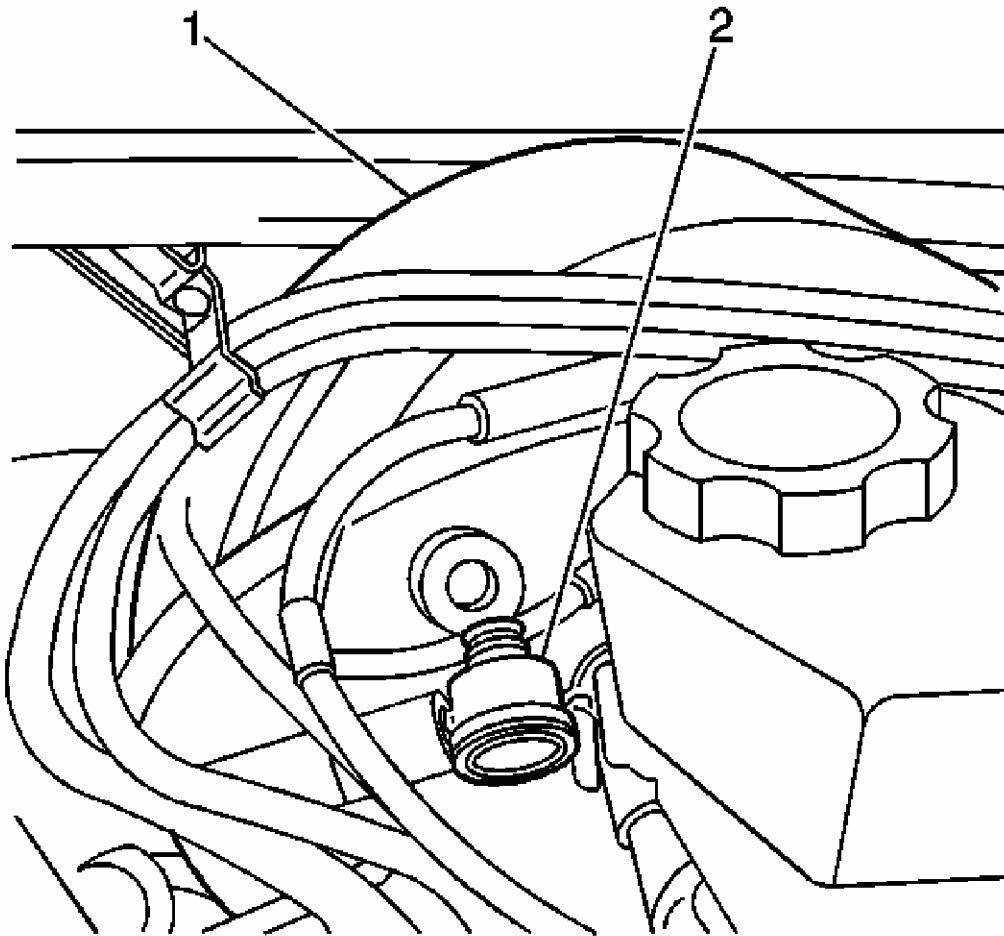


Fig. 54: View Of Vacuum Booster & Check Valve
Courtesy of GENERAL MOTORS CORP.

17. Install the brake booster vacuum check valve (2) to the vacuum brake booster.
18. Install the master cylinder to the vacuum brake booster. Refer to **Master Cylinder Replacement**.
19. Connect the fuel vapor lines in front of the brake booster.
 - For the lines that have the plastic connectors, refer to **Plastic Collar Quick Connect Fitting Service** .
 - For the lines that have the metal connectors, refer to **Metal Collar Quick Connect Fitting Service** .
20. Remove the blocks from the front wheels.
21. Release the parking brake.

POWER VACUUM BRAKE BOOSTER REPLACEMENT (3.8L V-6)

Removal Procedure

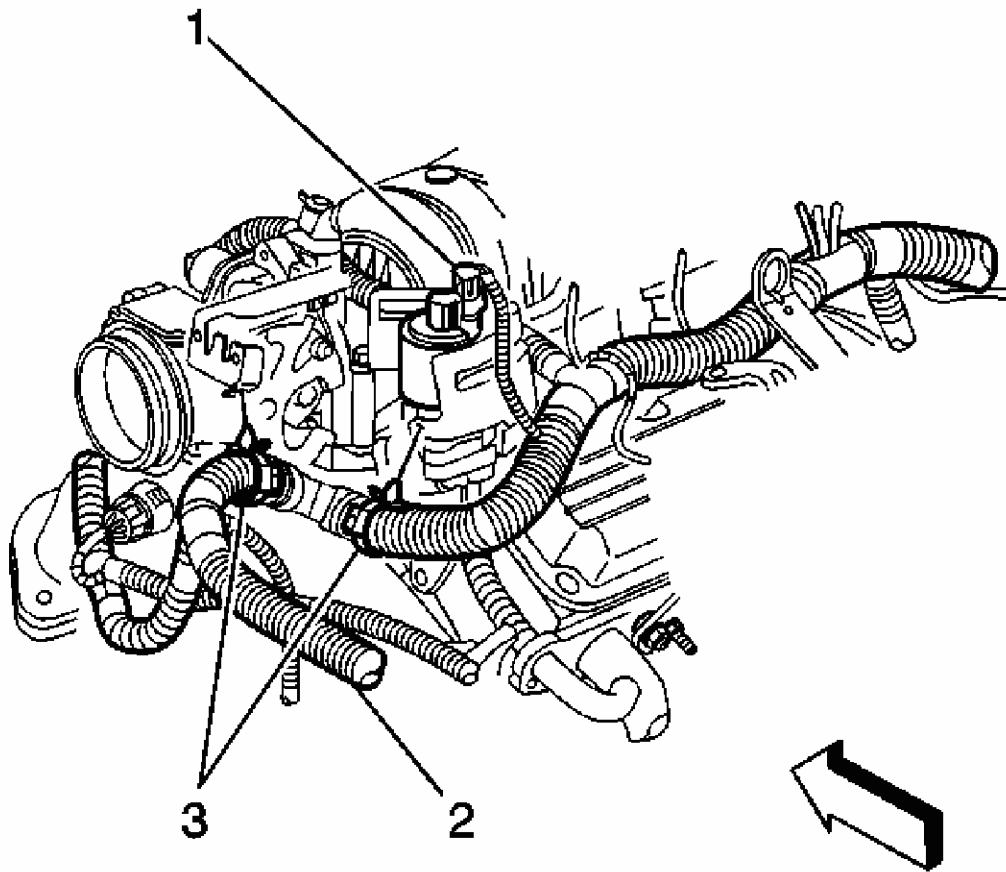


Fig. 55: View of EGR Valve, Engine Harness Clips & Wiring Harness
Courtesy of GENERAL MOTORS CORP.

1. Remove the fuel injector sight shield. Refer to **Intake Manifold Cover Replacement**.
2. Disconnect the electrical connector from the exhaust gas recirculation (EGR) valve (1).
3. Disconnect the engine harness clips (3).
4. Position the harness to the side.

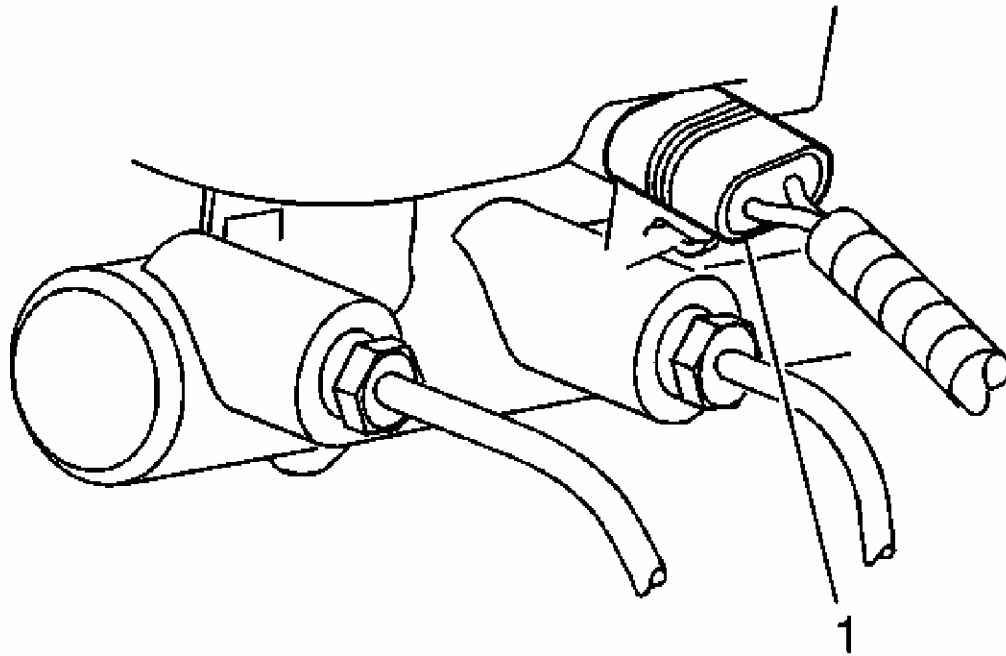


Fig. 56: View Of Brake Fluid Level Sensor Electrical Connector
Courtesy of GENERAL MOTORS CORP.

5. Disconnect the brake fluid level sensor (1).

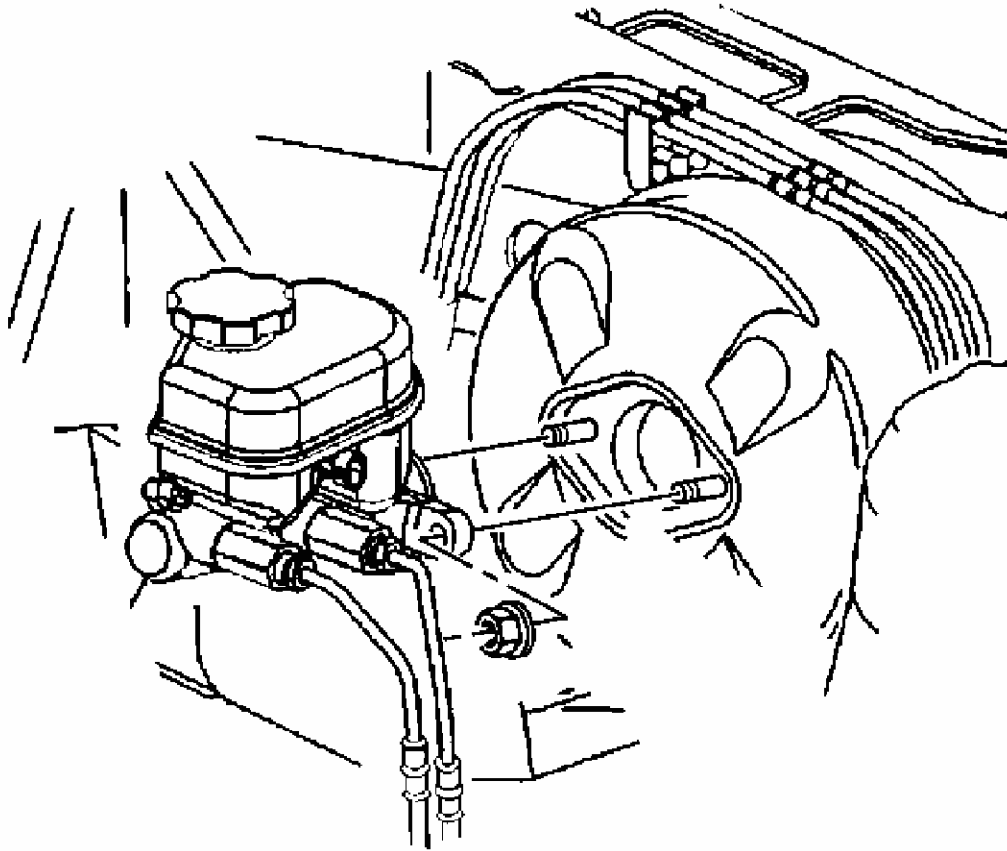


Fig. 57: Removing & Installing Master Cylinder
Courtesy of GENERAL MOTORS CORP.

6. Remove the master cylinder mounting bolts.
7. Remove the master cylinder. Position the master cylinder to the side.

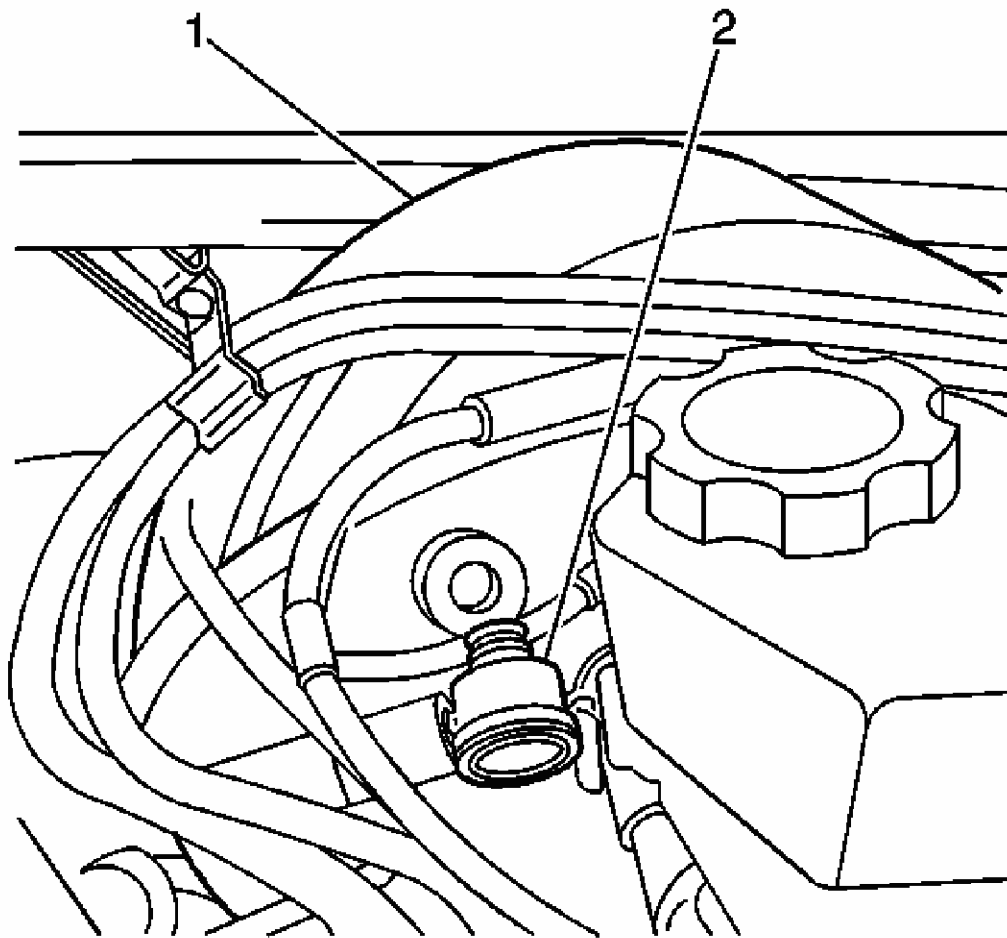


Fig. 58: View Of Vacuum Booster & Check Valve
Courtesy of GENERAL MOTORS CORP.

8. Disconnect the vacuum brake booster check valve and hose (2).
9. Remove the left knee bolster. Refer to **Driver Knee Bolster Replacement** .
10. Remove the steering column support mounting bolts. Refer to **Steering Column Replacement** .
11. Lower the steering column and support with mechanic's wire.
12. Disconnect the brake pedal position sensor (BBPS) electrical connector. Refer to **Brake Pedal Position Sensor Replacement** .

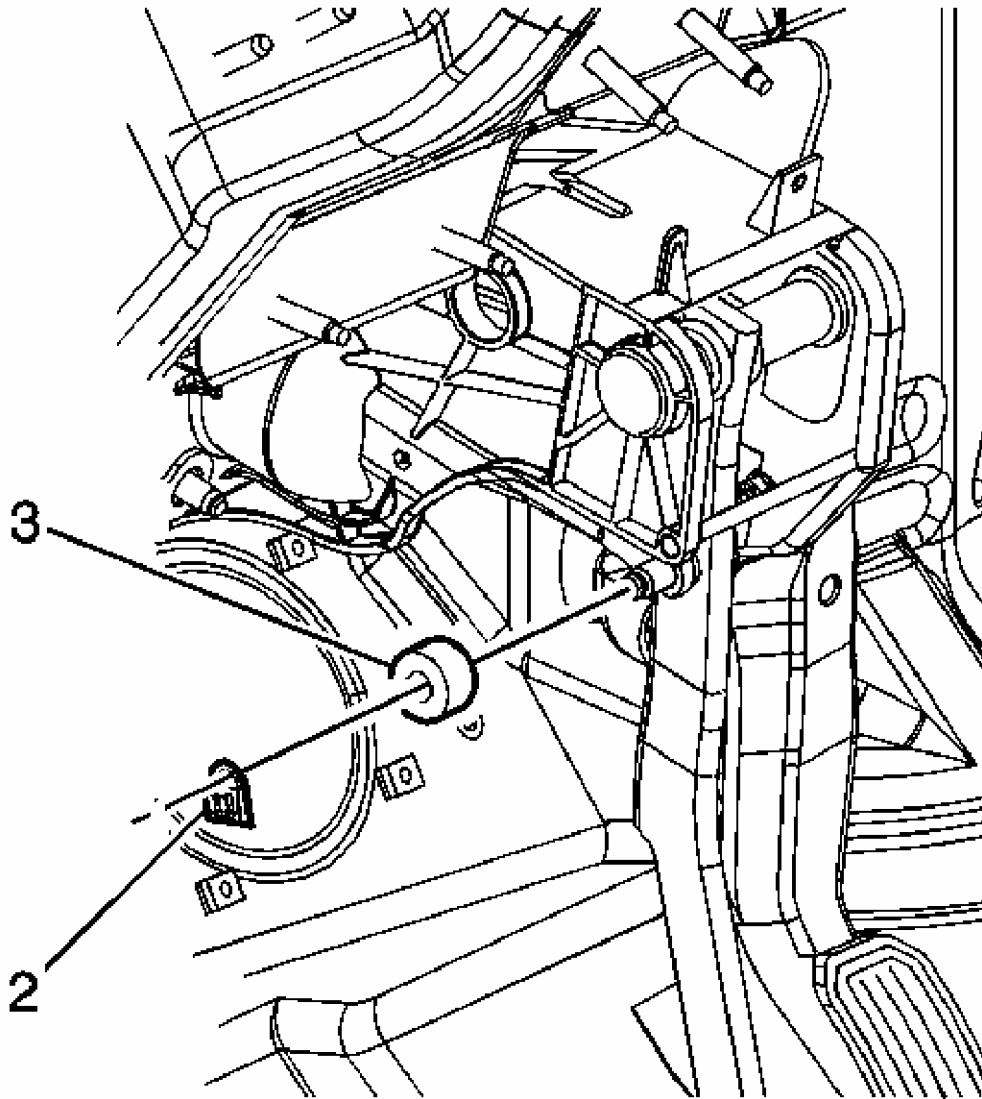


Fig. 59: Identifying Brake Pedal Clevis Pin
Courtesy of GENERAL MOTORS CORP.

13. Remove the vacuum brake booster pushrod retainer clip (2).
14. Remove the vacuum brake booster pushrod spacer (3).

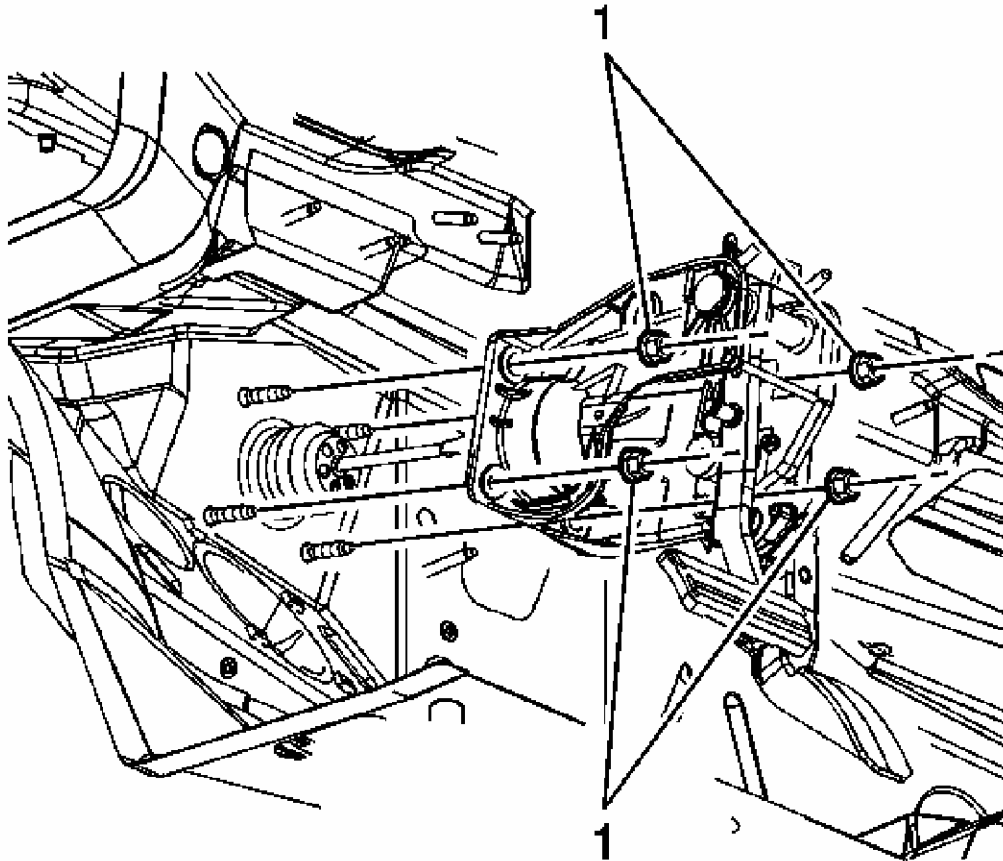


Fig. 60: Identifying Vacuum Brake Booster Mounting Nuts
Courtesy of GENERAL MOTORS CORP.

15. Remove the mounting nuts (1) for the steering column.

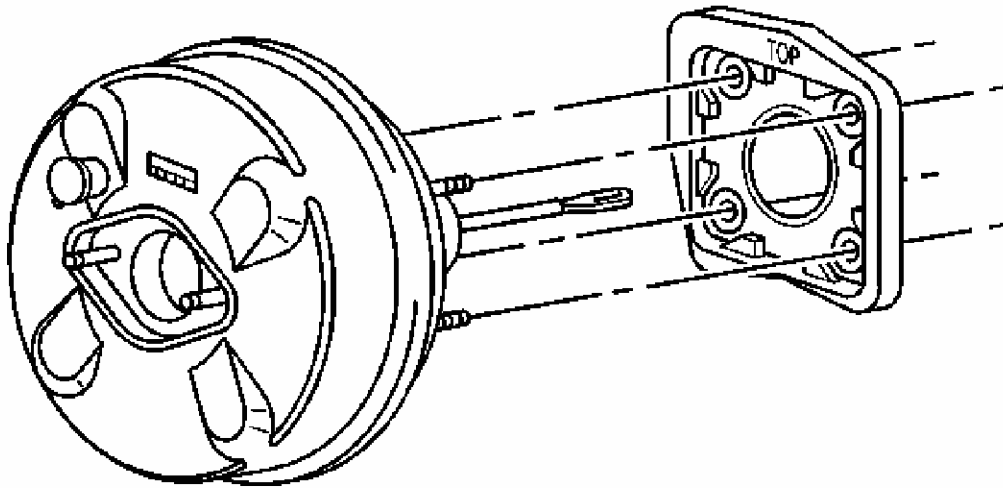


Fig. 61: View of Vacuum Brake Booster
Courtesy of GENERAL MOTORS CORP.

16. Remove the vacuum brake booster.

IMPORTANT: If the gasket is damaged, replace it. DO NOT reuse it, replace with new.

17. Remove the vacuum brake booster gasket.

Installation Procedure

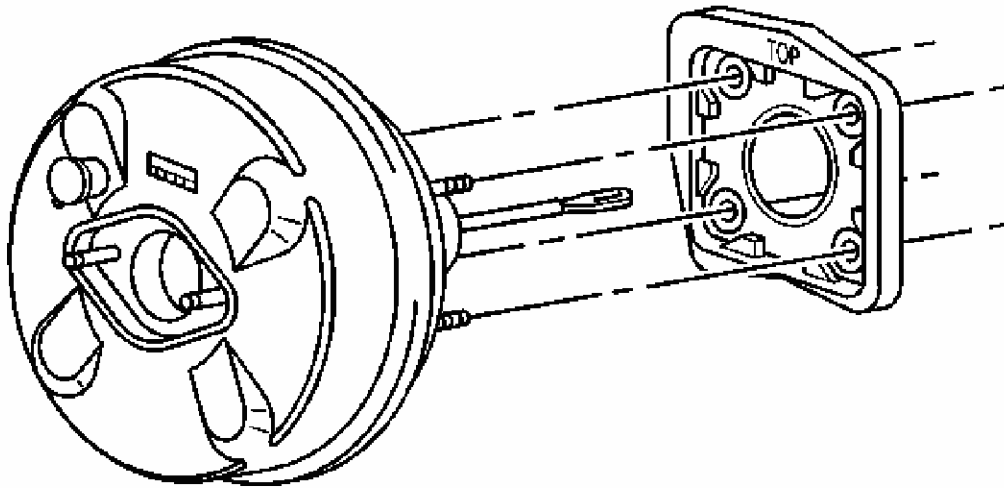


Fig. 62: View of Vacuum Brake Booster
Courtesy of GENERAL MOTORS CORP.

1. Install the vacuum brake booster gasket.
2. Install the vacuum brake booster.

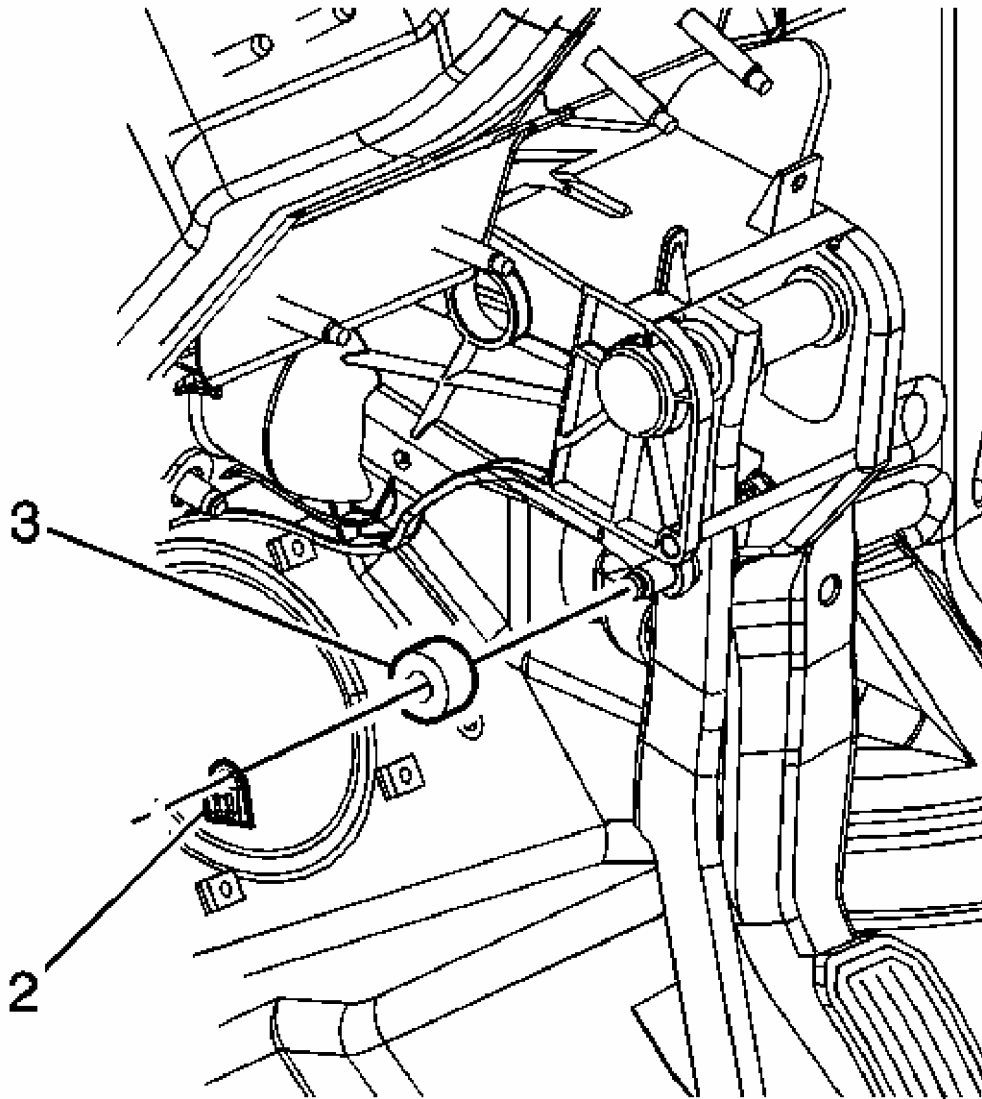


Fig. 63: Identifying Brake Pedal Clevis Pin
Courtesy of GENERAL MOTORS CORP.

3. Install the pushrod to the brake pedal.
4. Install the spacer (3).
5. Install the retaining clip (2).

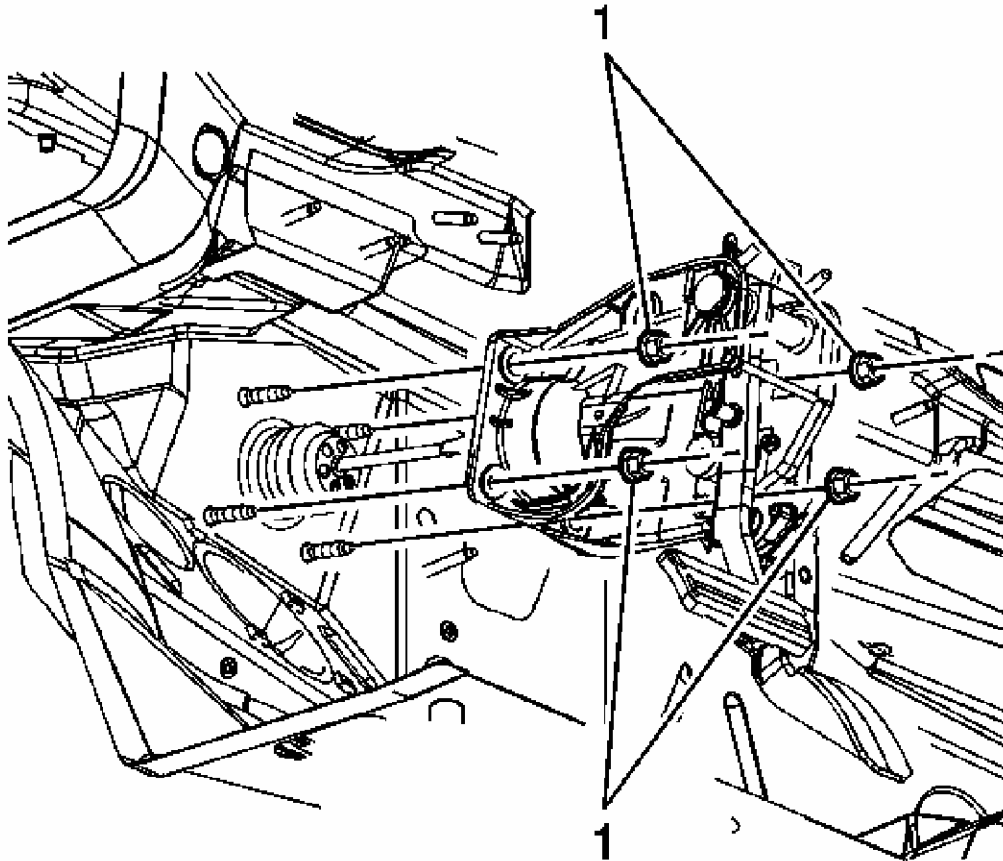


Fig. 64: Identifying Vacuum Brake Booster Mounting Nuts
Courtesy of GENERAL MOTORS CORP.

NOTE: Refer to Fastener Notice .

6. Install the mounting nuts (1).

Tighten: Tighten the nuts to 30 N.m (22 lb ft).

7. Connect the BPPS electrical connector to the BAS sensor. Refer to **Brake Pedal Position Sensor Replacement** .

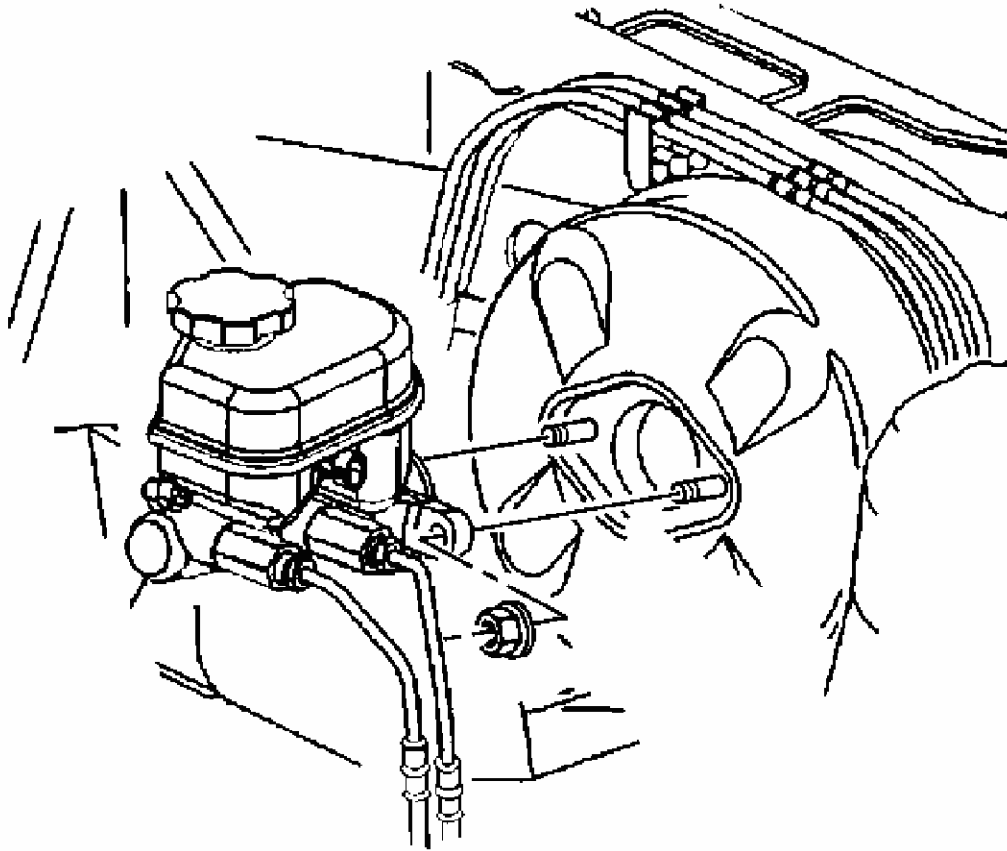


Fig. 65: Removing & Installing Master Cylinder
Courtesy of GENERAL MOTORS CORP.

8. Install the master cylinder. Refer to **Master Cylinder Replacement**.
9. Position the steering column.
10. Install the steering column. Refer to **Steering Column Replacement**.
11. Install the knee bolster panel. Refer to **Driver Knee Bolster Replacement**.

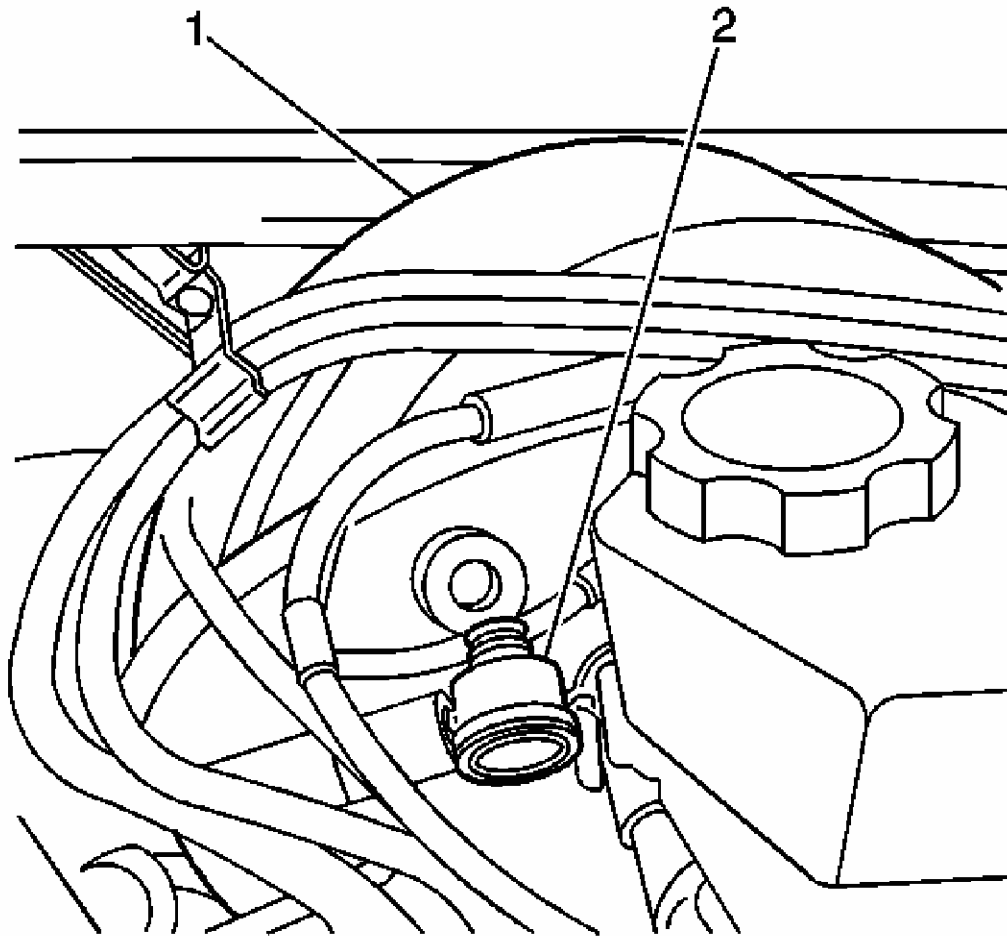


Fig. 66: View Of Vacuum Booster & Check Valve
Courtesy of GENERAL MOTORS CORP.

12. Install the vacuum brake booster check valve and hose (2).

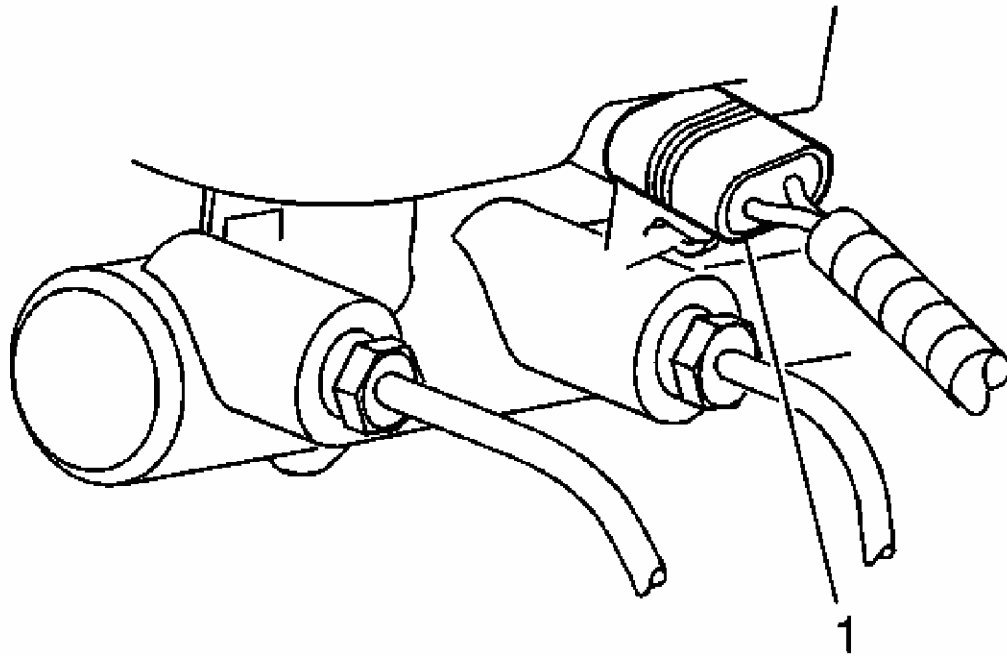


Fig. 67: View Of Brake Fluid Level Sensor Electrical Connector
Courtesy of GENERAL MOTORS CORP.

13. Install the brake fluid level sensor electrical connector (1).

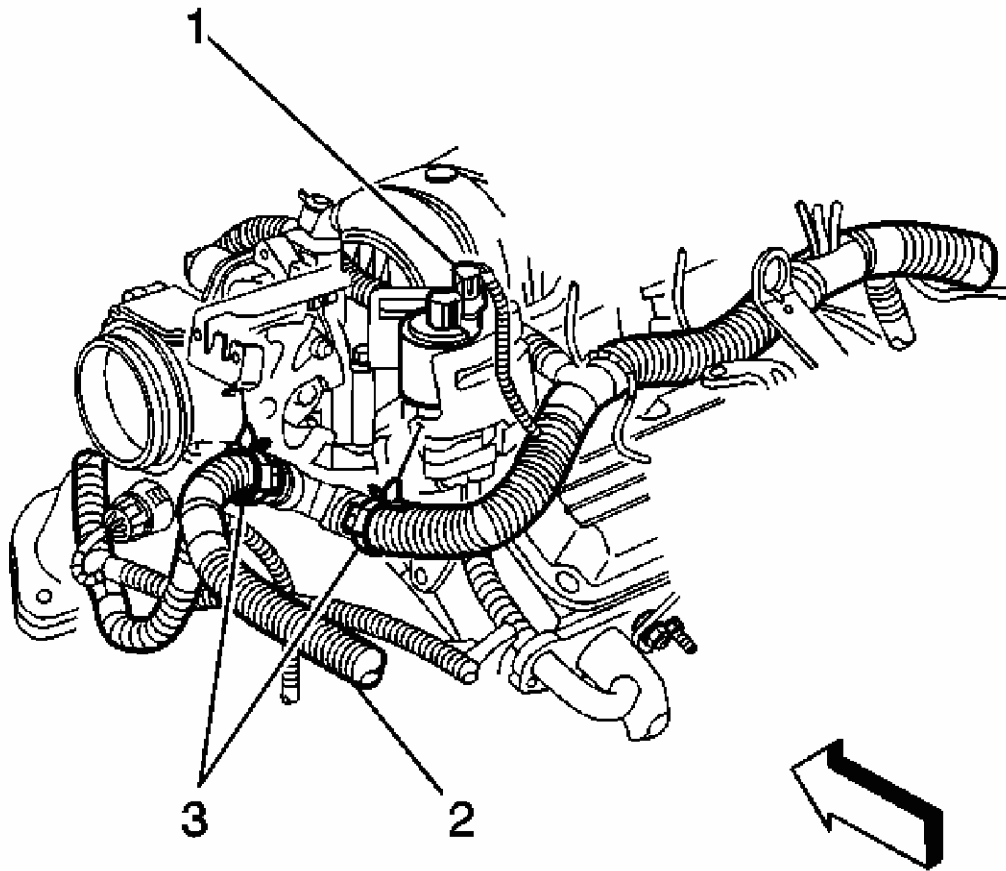


Fig. 68: View of EGR Valve, Engine Harness Clips & Wiring Harness
Courtesy of GENERAL MOTORS CORP.

14. Position the engine wiring harness (2).
15. Connect the electrical connector for the EGR valve (1).
16. Connect the engine harness clips (3).
17. Install the fuel injector sight shield. Refer to **Intake Manifold Cover Replacement** .

VACUUM BRAKE BOOSTER CHECK VALVE AND/OR HOSE REPLACEMENT

Removal Procedure

1. Remove the fuel injector sight shield. Refer to **Intake Manifold Cover Replacement** .

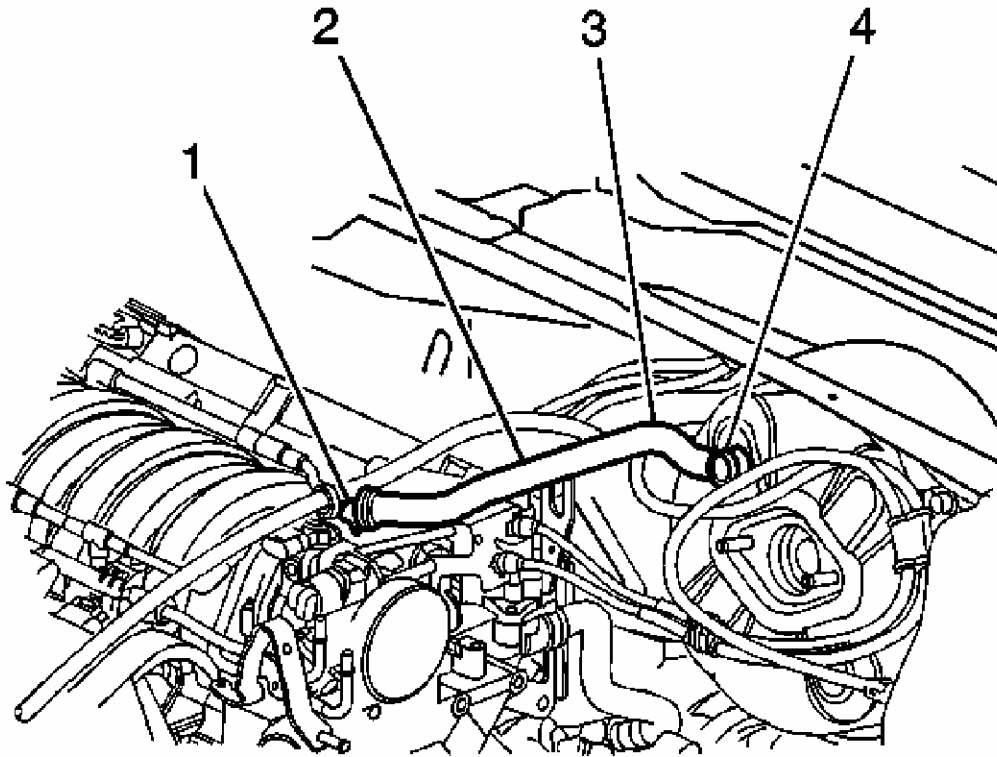
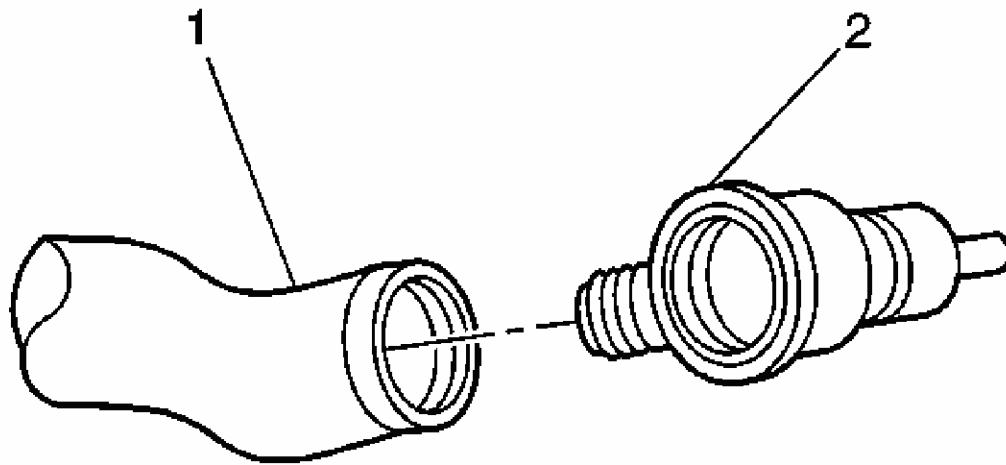


Fig. 69: Removing/Installing Vacuum Hose & Brake Booster Vacuum Check Valve

Courtesy of GENERAL MOTORS CORP.

2. Disconnect the vacuum hose (2) and vacuum brake booster check valve (4) from vacuum brake booster.
3. Disconnect the vacuum hose (2) from the intake manifold (1).



**Fig. 70: View Of Vacuum Brake Booster Check Valve And Vacuum Brake
Booster Hose**

Courtesy of GENERAL MOTORS CORP.

4. Remove the vacuum brake booster check valve (4) from the vacuum brake booster hose (2).

Installation Procedure

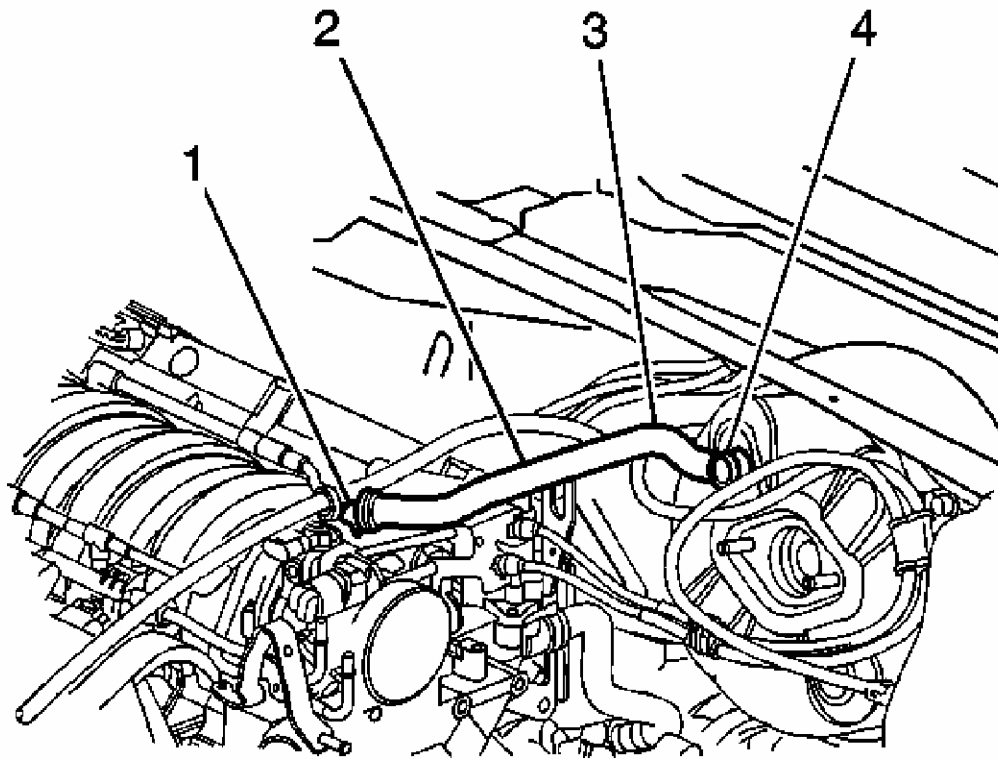


Fig. 71: Removing/Installing Vacuum Hose & Brake Booster Vacuum Check Valve

Courtesy of GENERAL MOTORS CORP.

1. Connect the vacuum hose (2) to the intake manifold (1).

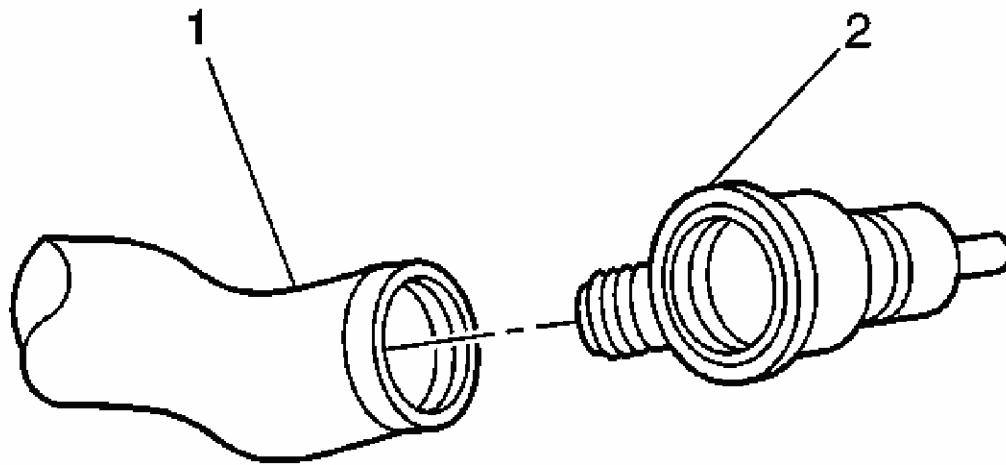


Fig. 72: View Of Vacuum Brake Booster Check Valve And Vacuum Brake Booster Hose

Courtesy of GENERAL MOTORS CORP.

2. Install the vacuum brake booster check valve (4) to the vacuum brake booster hose (1).
3. Connect the vacuum hose (2) and vacuum brake booster check valve to vacuum brake booster.
4. Install the fuel injector sight shield. Refer to **Intake Manifold Cover Replacement** .

DESCRIPTION AND OPERATION

BRAKE WARNING SYSTEM DESCRIPTION AND OPERATION

Brake System Indicators

Brake

The instrument panel cluster (IPC) illuminates the BRAKE indicator when any of the following occurs:

- The body control module (BCM) detects that the park brake is applied and sends serial data message to illuminate indicator.
- The IPC detects a low brake fluid condition.
- The electronic brake control module (EBCM) detects a malfunction with the antilock brake system (ABS). The IPC receives a serial data message from the EBCM requesting illumination.

- The IPC performs the displays test at the start of each ignition cycle. The indicator illuminates for approximately 5 seconds.

Check Brake Fluid

The IPC illuminates the CHECK BRAKE FLUID indicator in the driver information center (DIC) and sends a serial data message in order to activate an audible warning when the IPC detects that the brake fluid level is below the normal operating range.

HYDRAULIC BRAKE SYSTEM DESCRIPTION AND OPERATION**System Component Description**

The hydraulic brake system consists of the following:

Hydraulic Brake Master Cylinder Fluid Reservoir

Contains supply of brake fluid for the hydraulic brake system.

Hydraulic Brake Master Cylinder

Converts mechanical input force into hydraulic output pressure.

Hydraulic output pressure is distributed from the master cylinder through two hydraulic circuits, supplying diagonally-opposed wheel apply circuits.

Hydraulic Brake Pressure Balance Control System

Regulates brake fluid pressure delivered to hydraulic brake wheel circuits, in order to control the distribution of braking force.

Pressure balance control is achieved through dynamic rear proportioning (DRP), which is a function of the ABS modulator. Refer to **ABS Description and Operation** for specific information on the operation of DRP.

Hydraulic Brake Pipes and Flexible Brake Hoses

Carries brake fluid to and from hydraulic brake system components.

Hydraulic Brake Wheel Apply Components

Converts hydraulic input pressure into mechanical output force.

System Operation

Mechanical force is converted into hydraulic pressure by the master cylinder, regulated to meet braking system demands by the pressure balance control system and delivered to the hydraulic brake wheel circuits by the pipes and flexible hoses. The wheel apply components

then convert the hydraulic pressure back into mechanical force which presses linings against rotating brake system components.

BRAKE ASSIST SYSTEM DESCRIPTION AND OPERATION

System Component Description

The brake assist system consists of the following:

Brake Pedal

Receives, multiplies and transfers brake system input force from driver.

Brake Pedal Pushrod

Transfers multiplied input force received from brake pedal to brake booster.

Vacuum Brake Booster

Uses source vacuum to decrease effort required by driver when applying brake system input force.

When brake system input force is applied, air at atmospheric pressure is admitted to the rear of both vacuum diaphragms, providing a decrease in brake pedal effort required.

When input force is removed, vacuum replaces atmospheric pressure within the booster.

Vacuum Source

Supplies force used by vacuum brake booster to decrease brake pedal effort.

Vacuum Source Delivery System

Enables delivery and retention of source vacuum for vacuum brake booster.

System Operation

Brake system input force is multiplied by the brake pedal and transferred by the pedal pushrod to the hydraulic brake master cylinder. Effort required to apply the brake system is reduced by the vacuum brake booster.

SPECIAL TOOLS AND EQUIPMENT

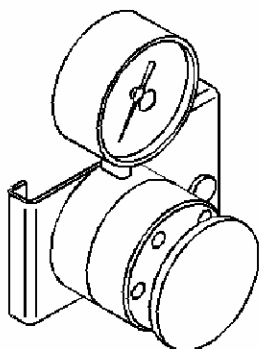
SPECIAL TOOLS

Special Tools

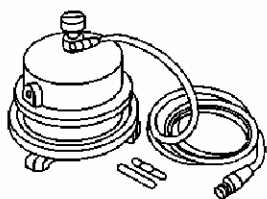
Illustration	Tool Number/Description

2006 Buick Lucerne CXS

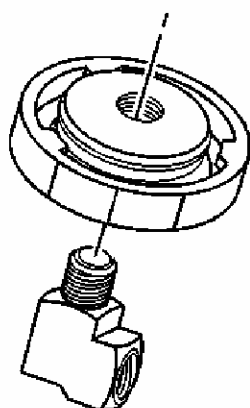
2006 BRAKES Hydraulic Brakes - Lucerne



J 28662
Brake Pedal Effort Gage



J 29532
Diaphragm Pressure Bleeder

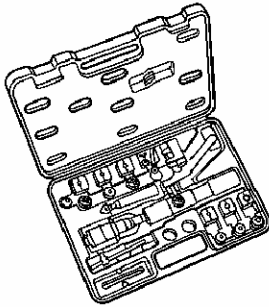


J 35589-A
Master Cylinder Bleeder Adapter

J 45405
Pipe Flaring Tool Kit

2006 Buick Lucerne CXS

2006 BRAKES Hydraulic Brakes - Lucerne



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